
FINAL REPORT

I-96 AT M-100 INTERCHANGE STUDY

**EAGLE TOWNSHIP
CLINTON COUNTY, MICHIGAN**

Prepared For:



**MICHIGAN DEPARTMENT OF TRANSPORTATION
UNIVERSITY REGION
JACKSON, MICHIGAN**

Prepared By:



DETROIT – FARMINGTON HILLS – GRAND RAPIDS – TRAVERSE CITY

SEPTEMBER 2006

Table of Contents

<u>Section</u>		<u>Page</u>
E.0 EXECUTIVE SUMMARY		E-1
E.1 Introduction.....		E-1
E.2 Existing (2006) and Future (2030) Conditions.....		E-1
E.2.1 Existing Conditions.....		E-1
E.2.2 Future Conditions		E-1
E.3 Alternatives.....		E-2
E.3.1 Tight-Diamond Interchange Alternative		E-2
E.3.2 Partial Cloverleaf Interchange Alternative		E-2
E.3.3 Modern Roundabout Alternative.....		E-3
E.3.4 Relocated Eastbound Ramps Alternative.....		E-3
E.4 Conclusions and Recommendations		E-3
1.0 INTRODUCTION.....		1-1
1.1 Background		1-1
1.2 Report Organization		1-1
2.0 EXISTING AND FUTURE CONDITIONS.....		2-1
2.1 Study Area.....		2-1
2.2 Existing Conditions (2006) Capacity Analysis		2-1
2.3 Future Conditions (2030).....		2-3
2.3.1 Background Traffic Growth.....		2-3
2.3.2 No-Build Alternative (2030) Capacity Analysis		2-4
2.4 Environmental Screening		2-5
2.4.1 Northeast Quadrant.....		2-5
2.4.2 Northwest Quadrant		2-6
2.4.3 Southeast Quadrant		2-6
2.4.4 Southwest Quadrant.....		2-6
2.4.5 Area of Relocated Eastbound Ramps Interchange Alternative		2-7
2.5 Conclusions.....		2-7
3.0 ALTERNATIVES.....		3-1
3.1 Description of Alternatives.....		3-1
3.1.1 Tight-Diamond Interchange Alternative		3-1
3.1.2 Partial Cloverleaf Interchange Alternative		3-1
3.1.3 Modern Roundabout Alternative.....		3-1
3.1.4 Relocated Eastbound Ramps Alternative.....		3-2
3.2 Evaluation of Alternatives		3-2
3.2.1 Traffic Operations.....		3-2
3.2.2 Project Cost.....		3-3
3.3 Conclusions and Recommendations		3-4

Appendices

Appendix A	Existing Conditions Capacity Analysis Worksheets
Appendix B	No-Build Future Conditions Capacity Analysis Worksheets
Appendix C	Build Future (2030) Conditions Capacity Analysis Worksheets
Appendix D	Detailed Construction Cost Breakdowns

List of Tables

<u>Table</u>		<u>Page</u>
2-1	Peak Hour Level-of-Service Ranges – Highway Capacity Manual (2000).....	2-2
2-2	Existing (2006) Peak Hour Level-of-Service – Signalized/Unsignalized Intersections	2-2
2-3	Existing (2006) Peak Hour Level-of-Service – Basic Freeway Segments	2-3
2-4	Existing (2006) Peak Hour Level-of-Service – Freeway/Ramp Junctions	2-3
2-5	Future-Year (2030) Peak Hour Level-of-Service – Signalized/Unsignalized Intersections (No-Build Alternative)	2-4
2-6	Future-Year (2030) Peak Hour Level-of-Service – Basic Freeway Segments (No-Build Alternative)....	2-4
2-7	Future-Year (2030) Peak Hour Level-of-Service – Freeway/Ramp Junctions (No-Build Alternative)....	2-5
3-1	Future-Year (2030) Peak Hour Level-of-Service – Signalized/Unsignalized Intersections (Build Alternatives)	3-3
3-2	Preliminary Construction Cost Estimates – Build Alternatives.....	3-4

List of Figures

<u>Figure</u>		<u>Page</u>
1-1	I-96 at M-100 Interchange Vicinity Map.....	1-2
2-1	Existing Interchange	2-8
2-2	Existing (2006) Peak-Hour Traffic Volumes & Level-of-Service	2-9
2-3	Future (2030) Peak-Hour Traffic Volumes & Level-of-Service – No-Build Alternative.....	2-10
3-1	Tight Diamond Interchange Alternative	3-5
3-2	Low-Capital Tight Diamond Interchange Alternative	3-6
3-3	I-96 at M-100 Existing and Proposed Vertical Profiles – Diamond and Roundabout Alternatives	3-7
3-4	Parclo Interchange Alternative	3-8
3-5	I-96 at M-100 Existing and Proposed Vertical Profiles – Parclo Interchange Alternative	3-9
3-6	Modern Roundabout Interchange Alternative	3-10
3-7	Relocated Eastbound Ramps Interchange Alternative	3-11
3-8	Future (2030) Peak Hour Volumes & Level of Service – Tight-Diamond Interchange Alternative.....	3-12
3-9	Future (2030) Peak Hour Volumes & Level of Service – Parclo Interchange Alternative	3-13
3-10	Future (2030) Peak Hour Volumes & Level of Service – Modern Roundabout Alternative	3-14
3-11	Future (2030) Peak Hour Volumes & Level of Service – Relocated Eastbound Ramps Alternative	3-15

E.0 Executive Summary

E.1 Introduction

The interchange of I-96 and M-100 is located west of the City of Lansing in Eagle Township, Clinton County. The existing interchange consists of a tight-diamond configuration with a two-lane two-way bridge carrying M-100 over I-96. The existing bridge over I-96 has substandard underclearance (14'-1"), and the vertical curvature of M-100 over I-96 is also less-than-standard. In response to these circumstances, the Michigan Department of Transportation (MDOT) has authorized this "I-96 at M-100 Interchange Study".

The purpose of this interchange study is to develop and examine feasible future capacity and geometric improvement alternatives at the I-96/M-100 interchange—including replacing the existing M-100 bridge over I-96 with standard vertical clearance—so that the interchange can serve future-year (2030) peak-hour traffic volumes safely and at an acceptable Level-of-Service. Following discussions with MDOT representatives, the alternatives deemed feasible included two Tight-Diamond Interchange Alternatives (with increased capacity and revised geometry), a Partial-Cloverleaf (Parclo) Interchange, a Modern Roundabout Alternative, and a Relocated Eastbound Ramps Alternative. These interchange alternatives were compared based on cost and functionality.

E.2 Existing (2006) and Future (2030) Conditions

E.2.1 Existing Conditions

Hourly traffic counts provided by the Michigan Department of Transportation (MDOT) were supplemented with additional peak-hour traffic counts collected in January 2006. Peak-hour counts were collected for the I-96/M-100 interchange ramps as well as the M-100/Grand River Avenue intersection. The existing (2006) peak-hour Levels-of-Service for the I-96/M-100 signalized ramp terminal intersections and the M-100/Grand River Avenue intersection were calculated using the methods of the 2000 Highway Capacity Manual. The study area intersections operate at Level-of-Service "C" or better during existing peak hours.

The existing (2006) peak-hour Levels-of-Service for the basic freeway segments along I-96 within the study area were also calculated. Each basic freeway segment operates at Level-of-Service (LOS) "C" or better during existing peak hours.

Finally, the existing (2006) peak-hour Levels-of-Service for the various freeway/ramp junctions at the I-96/M-100 interchange were calculated. Each freeway/ramp junction operates at LOS "C" during existing peak hours.

E.2.2 Future Conditions

Future-year (2030) traffic projections for the I-96/M-100 interchange were developed in consultation with MDOT staff and the Tri-County Regional Planning Commission. In order to estimate future-year (2030) peak-hour traffic volumes along I-96 and M-100, the existing (2006) peak-hour traffic volumes were increased using annually-compounding growth rates between 0.5% and 2.5%.

The future-year (2030) peak-hour Levels-of-Service for the I-96/M-100 signalized ramp terminal intersections and the M-100/Grand River Avenue intersection were calculated assuming no changes to existing capacity. The results of the analysis indicate that the M-100/Grand River Avenue intersection is anticipated to operate at Level-of-Service "F" during future-year (2030) morning and afternoon peak hours.

The future-year (2030) peak-hour Levels-of-Service for the basic freeway segments at the interchange were also calculated. The results indicate that the basic freeway segments are anticipated to operate at acceptable Levels-of-Service during future-year (2030) peak hours, except eastbound I-96, east of M-100, which is anticipated to operate at Level-of-Service "E" during the morning peak hour, and westbound I-96, east and west of M-100, which is anticipated to operate at Level-of-Service "E" during the afternoon peak hour.

The future-year (2030) peak-hour Levels of Service for the freeway/ramp junctions at the interchange were also calculated. The results indicate that the freeway/ramp junctions are anticipated to operate at acceptable Levels-of-Service during future-year (2030) peak hours, except the eastbound I-96 off-ramp and on-ramp, which are anticipated to operate at Level-of-Service "E" during the morning peak hour, and the westbound off-ramp and on-ramp, which operate at Level-of-Service "F" and "E", respectively, during the afternoon peak hour.

Based on these results, an additional lane in each direction of I-96 may be necessary in the next 20-25 years.

E.3 Alternatives

E.3.1 Tight-Diamond Interchange Alternative

The first alternative consists of simply increasing the capacity of the existing tight-diamond interchange. Two variations of the Tight-diamond Interchange Alternative were studied. The Tight-Diamond Interchange Alternative involves widening M-100 into a 3-lane section over I-96. A new bridge over I-96 would provide one lane in each direction of M-100 and a two-way center left-turn lane.

Separate left- and right-turn lanes would be constructed on each off-ramp approach to M-100. A right-turn bay would be constructed at the eastbound I-96 ramp terminal intersection to provide additional capacity for the northbound-to-eastbound turn movement. The profile of M-100 over I-96 would be modified to improve sight distance.

The difference between the two tight-diamond interchange variations is the alignment of the ramps. Variation #1 incorporates a "spread" ramp treatment which improves intersection turning radii and could minimize the potential for truck rollovers, while Variation #2 is a standard tight-diamond interchange treatment (with skewed ramps).

Right-of-way (ROW) would be necessary in the northeast and southwest quadrants to provide acceptable geometry for the ramp terminal intersections with Variation #2 and along both sides of Wright Road, north of the interchange because of the fill necessary to improve the vertical profile for both variations. The estimated construction cost of the Tight-Diamond Interchange Alternative Variation #1 is \$ 9,800,000 including right-of-way costs, while the estimated cost of the Tight-Diamond Interchange Alternative Variation #2 is \$ 8,120,000 including right-of-way costs.

E.3.2 Partial Cloverleaf Interchange Alternative

The second alternative is the Partial Cloverleaf (Parclo) Interchange Alternative. The Parclo Interchange Alternative involves the construction of a loop ramp in the northwest quadrant of the interchange.

The loop in the northwest quadrant would serve the westbound-to-southbound left-turn movement under STOP control. The westbound off-ramp would be located along the current alignment and would service the westbound-to-northbound movement under STOP control. The bridge over I-96 would carry three lanes of traffic. The profile of M-100 over I-96 would be modified to improve sight distance.

Significant right-of-way would need to be acquired in the northwest quadrant of the interchange in order to provide for the construction of the loop ramp. The estimated construction cost of Parclo Interchange Alternative is \$ 9,540,000 not including right-of-way costs.

E.3.3 Modern Roundabout Alternative

The third alternative is the Modern Roundabout Alternative. The Modern Roundabout Alternative involves the construction of a modern roundabout intersection at each ramp terminal. The existing off-ramps would be reconstructed to current standards and to allow for proper traffic flow into the roundabout intersections. The right-turning movements entering the roundabouts would operate under yield control. The bridge over I-96 would carry two lanes of traffic—one through lane in each direction. The profile of M-100 over I-96 would be modified to improve sight distance.

Small pieces of right-of-way may be necessary in the each of the four quadrants to provide acceptable geometry for the ramp terminal intersections, with additional ROW necessary along both sides of Wright Road, north of the interchange because of the fill necessary to improve the vertical profile. The estimated construction cost of the Modern Roundabout Alternative is \$ 7,690,000 including right-of-way costs.

E.3.4 Relocated Eastbound Ramps Alternative

The final alternative is the Relocated Eastbound Ramps Alternative. The Relocated Eastbound Ramps Alternative involves relocating the eastbound I-96 ramps so they intersect Grand River Avenue approximately at the existing Park-N-Ride lot. The existing eastbound I-96 ramps would be removed. A two-way center left-turn lane would be constructed on Grand River Avenue from M-100 to the eastbound ramp terminal intersection. The westbound I-96 ramps would be constructed as shown in the Tight-Diamond Alternative. The bridge over I-96 would carry three lanes of traffic—one through lane in each direction and a two-way center left-turn lane. The profile of M-100 over I-96 would be modified to improve sight distance.

Small pieces of right-of-way may be necessary in the southeast and northwest quadrants of the M-100/Grand River Avenue intersection to provide improved turning radii for truck traffic. Additional ROW will be necessary at the westbound I-96 ramp terminal intersection as detailed in the Tight-Diamond Interchange Alternative. The estimated construction cost of the Relocated Eastbound Ramps Alternative is \$ 10,700,000, not including right-of-way costs.

E.4 Conclusions and Recommendations

The Tight-Diamond Interchange Alternative also provides acceptable LOS values for the various traffic movements within the interchange. The proposed ramps provide improved acceleration and deceleration lengths. A three-lane bridge is necessary to provide storage for the northbound-to-westbound and southbound-to-eastbound left-turn movements. The two variations examined require right-of-way along Wright Road north of I-96. Additional right-of-way is necessary for the Tight-Diamond Interchange Alternative (Variation #1) to reduce the skew of the existing ramp terminal intersections.

The Parclo Interchange Alternative provides acceptable LOS values under future-year peak-hour conditions, with LOS "C" or better for each of the signalized and unsignalized ramp terminal intersections. The Parclo Interchange Alternative suffers from high construction costs. Right-of-way costs are not known for the Parclo Interchange Alternative, but significant right-of-way acquisition is required.

The Modern Roundabout Alternative provides acceptable LOS values for the various traffic movements within the interchange. Additionally, the Modern Roundabout Alternative can be constructed with very little right-of-way acquisition. The Modern Roundabout Alternative is the least expensive alternative, as it requires only a two-lane bridge.

The Relocated Eastbound Ramps Alternative provides acceptable traffic operations, as each traffic movement operates at LOS "C" or better. The Relocated Eastbound Ramps Alternative requires significant right-of-way acquisition

and may impact a wetland area. The Relocated Eastbound Ramps Alternative has the highest construction costs due to roadwork involved on Grand River Avenue. Right-of-way costs are not known for the Relocated Eastbound Ramps Alternative, but significant right-of-way acquisition is required.

Based on the analyses completed herein, it is recommended that MDOT pursue the Tight-Diamond Interchange Alternative (Variation #2). The Tight-Diamond Interchange Alternative (Variation #2) can be constructed to the latest road and bridge design standards with minimal right-of-way expenses. While the Modern Roundabout Alternative costs less, it may not be favorable given that not enough information is available to determine how the Modern Roundabout Alternative would be affected by the possible future signalization of the M-100/Grand River Avenue intersection.

1.0 INTRODUCTION

1.1 Background

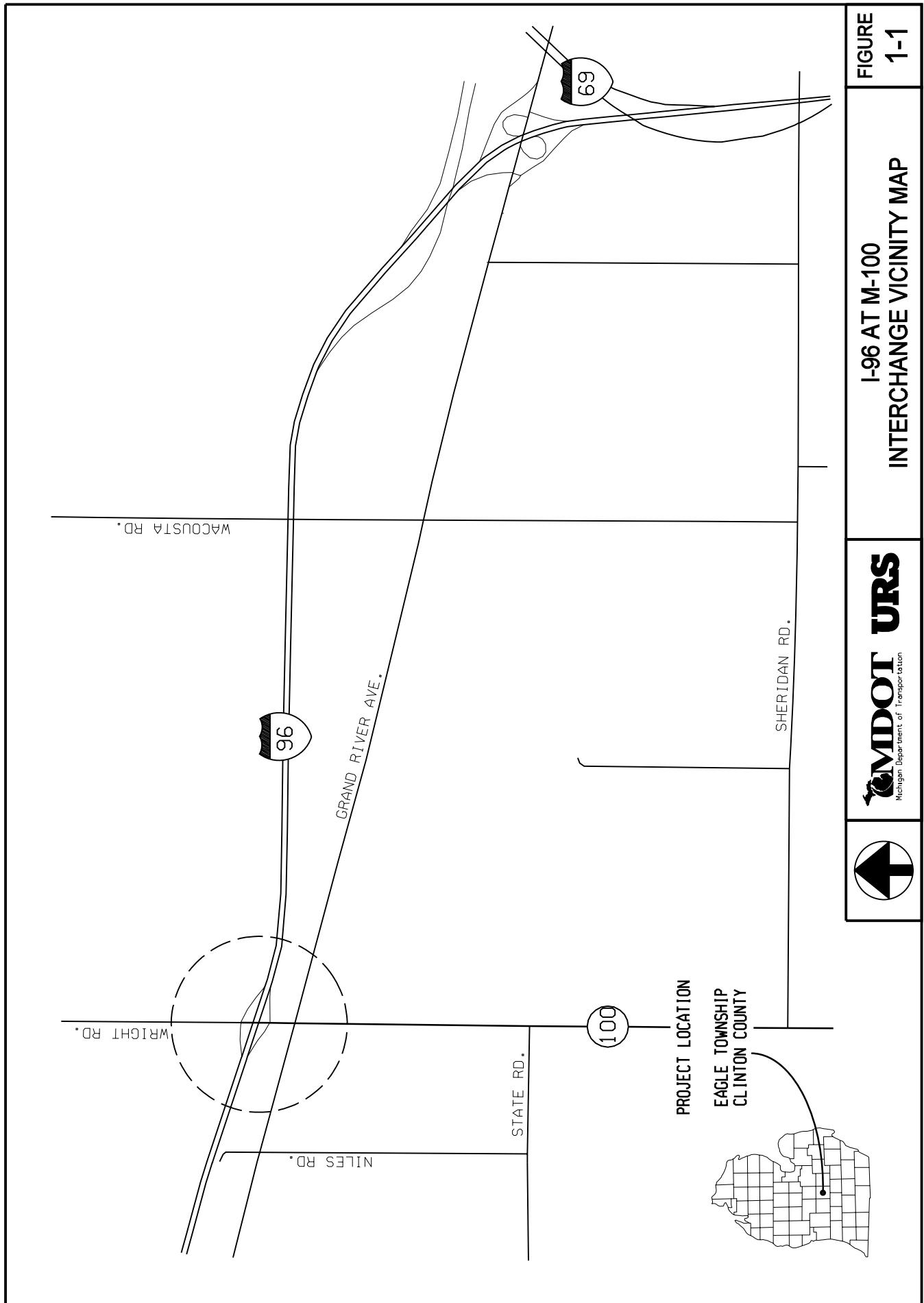
The interchange of I-96 and M-100 is located west of the City of Lansing in Eagle Township, Clinton County. A site map is depicted in **Figure 1-1**. The existing interchange consists of a tight-diamond configuration with a two-lane two-way bridge carrying M-100 over I-96. The existing bridge over I-96 has substandard underclearance (14'-1"), and the vertical curvature of M-100 over I-96 is also less-than-standard. In response to these circumstances, the Michigan Department of Transportation (MDOT) has authorized this "I-96 at M-100 Interchange Study".

The purpose of this interchange study is to develop and examine feasible future capacity and geometric improvement alternatives at the I-96/M-100 interchange—including replacing the existing M-100 bridge over I-96 with standard vertical clearance—so that the interchange can serve future-year (2030) peak-hour traffic volumes safely and at an acceptable Level-of-Service. Following discussions with MDOT representatives, the alternatives deemed feasible included a Tight-Diamond Interchange Alternative (with increased capacity and revised geometry), a Partial-Cloverleaf (Parclo) Interchange, a Modern Roundabout Alternative, and a Relocated Eastbound Ramps Alternative. These interchange alternatives were compared based on cost and functionality.

1.2 Report Organization

This report is organized into the following sections:

- 2.0 *Existing and Future Conditions* – This section provides an evaluation of existing traffic operations and future traffic operations at the I-96/M-100 interchange.
- 3.0 *Alternatives* – This section provides a description of the various concepts developed, followed by a comparative evaluation of the concepts with the existing interchange configuration. Evaluations were based on traffic operations, safety, and construction cost. Conclusions and recommendations are also provided.



2.0 EXISTING AND FUTURE CONDITIONS

All analyses documented in this report were performed in accordance with MDOT, FHWA, and AASHTO practices, guidelines, policies, and standards, including the 2000 Highway Capacity Manual (HCM), A Policy on Geometric Design of Highways and Streets (AASHTO, 2004) and the Michigan Manual of Uniform Traffic Control Devices (MMUTCD, 2005).

2.1 Study Area

The study area includes the following facilities:

I-96 is a four-lane east-west freeway through the study area. The speed limit of I-96 is 70 mph. The Average Daily Traffic (ADT) of I-96 is 39,300 vehicles per day west of M-100 and 36,400 vehicles per day east of M-100. I-96 carries approximately 11 percent commercial traffic.

M-100 is a north-south two-lane two-way state trunkline with a 55-mph speed limit. M-100 extends from I-96 south to I-69 and is also called Wright Road in the study area. North of I-96, Wright Road is a county primary route. The right-of-way width of M-100 (south of I-96) and Wright Road (north of I-96) is 100 feet. The ADT of M-100 is 7,100 vehicles per day south of I-96. The ADT of Wright Road north of I-96 is approximately 5,000 vehicles per day. M-100 carries approximately 8 percent commercial traffic in the study area.

The **I-96 / M-100** interchange configuration is a standard tight-diamond layout. Each off-ramp terminal intersection at M-100 is signalized with lagging protected left-turn phases to clear the 560-foot space along M-100 over the bridge between the ramps. The existing interchange is depicted in **Figure 2-1**. The existing profile of M-100 over I-96 does not meet current standards for bridge under-clearance and vertical profile.

The I-96/M-100 interchange provides the main access to the City of Grand Ledge from I-96.

2.2 Existing Conditions (2006) Capacity Analysis

Hourly traffic counts provided by the Michigan Department of Transportation (MDOT) were supplemented with additional peak-hour turning movement counts collected in January 2006. Peak-hour counts were collected at the I-96/M-100 ramp terminal intersections as well as at the M-100/Grand River Avenue intersection. The existing (2006) peak-hour volumes are displayed on **Figure 2-2** for the morning and afternoon peak hours.

The methods of the 2000 Highway Capacity Manual (HCM) were used to perform a capacity analysis of the I-96/M-100 interchange. Conventional analysis of basic freeway segments, freeway/ramp junctions, and signalized intersections involves the determination of a "Level-of-Service" (LOS). Levels of Service range from "A" to "F", similar to an alphabetic grading system, with each level describing a different set of operational characteristics. LOS "A" describes operational performance under light traffic volumes (freeway segments and freeway/ramp junctions) or with minimal delay (at signalized intersections). LOS "F" describes a high density of freeway and ramp congestion or intersection failure with extensive delays and long vehicular queues. LOS "C" or "D" is considered acceptable for peak-hour traffic operation of freeway segments, freeway/ramp junctions, and at signalized intersections in urbanized areas according to AASHTO.

The Level-of-Service criteria defined by the HCM is described in **Table 2-1** for basic freeway segments, freeway/ramp junctions, signalized and unsignalized intersections. As shown in Table 2-1, density is the performance measure used to define the limits of each Level-of-Service for basic freeway segments and freeway/ramp junctions. Control delay is the performance measure used for signalized and unsignalized intersections. Control delay includes

all delay caused by traffic control (whether it is a traffic signal or STOP sign), which includes deceleration delay, time spent waiting at the intersection, and acceleration delay.

TABLE 2-1
PEAK-HOUR LEVEL-OF-SERVICE RANGES
HIGHWAY CAPACITY MANUAL (2000)

Level-of-Service	Freeway Segments	Freeway / Ramp Junctions	Signalized Intersections	Unsignalized Intersections
	Density (pc/mi)	Density (pc/mi)	Control Delay (sec/veh)	Control Delay (sec/veh)
A	≤11	≤10	≤10	≤10
B	11 – 18	10 – 20	10 – 20	10 – 15
C	18 – 26	20 – 28	20 – 35	15 – 25
D	26 – 35	28 – 35	35 – 55	25 – 35
E	35 – 45	>35	55 – 80	35 – 50
F	>45	Demand exceeds capacity	>80	>50

Source: 2000 Highway Capacity Manual

The existing (2006) peak-hour Levels-of-Service for the I-96/M-100 signalized ramp terminal intersections are depicted in **Table 2-2**. As shown in Table 2-2, the I-96 signalized ramp terminal intersections operate at LOS "B" during the morning and afternoon peak hours. A review of Figure 2-2, which depicts the LOS values associated with each individual turning movement, reveals that the left-turn movement at the westbound ramp terminal intersection operates at LOS "D" during the morning and afternoon peak hours and the southbound approach of the M-100/Grand River Avenue intersection operates at LOS "D" during the morning peak hour. Capacity analysis worksheets for all existing (2006) signalized intersection capacity analyses are included in **Appendix A** of this report.

TABLE 2-2
EXISTING (2006) PEAK HOUR LEVEL-OF-SERVICE
SIGNALIZED/UNSIGNALIZED INTERSECTIONS

M-100 Intersection	Traffic Control	2006 AM Peak Hour		2006 PM Peak Hour	
		Level of Service	Control Delay (sec/veh)	Level of Service	Control Delay (sec/veh)
1. Eastbound I-96 off-ramp	Signal	B	14.0	B	12.5
2. Westbound I-96 off-ramp	Signal	B	15.0	B	17.4
3. Grand River Avenue	4-way STOP	C	22.4	C	20.1

Source: URS Corporation, September 2006

The existing (2006) peak-hour Levels-of-Service for the basic freeway segments along I-96 within the study area are depicted in **Table 2-3** on the next page. According to the Highway Capacity Manual, a basic freeway segment is a segment of the freeway that is outside of the influence area of ramps or weaving areas of the freeway. As shown in Table 2-3 each basic freeway segment operates at LOS "C" or better during existing peak hours. Capacity analysis worksheets for all existing (2006) basic freeway segment analyses are included in **Appendix A** of this report.

TABLE 2-3
EXISTING (2006) PEAK HOUR LEVEL-OF-SERVICE
BASIC FREEWAY SEGMENTS

I-96 Freeway Segment	2006 AM Peak Hour			2006 PM Peak Hour		
	Volume	Density	LOS	Volume	Density	LOS
Eastbound I-96						
1. West of M-100	2,220	18.4	C	1,560	13.1	B
2. East of M-100	2,475	20.8	C	1,680	14.1	B
Westbound I-96						
1. West of M-100	1,365	11.4	B	2,260	18.9	C
2. East of M-100	1,405	11.8	B	2,515	21.1	C

Source: URS Corporation, September 2006

The existing (2006) peak-hour Levels-of-Service for the various freeway/ramp junctions at the I-96/M-100 interchange are depicted in **Table 2-4**. As shown in Table 2-4, each freeway/ramp junction operates at LOS "B" during existing peak hours. Capacity analysis worksheets for all existing (2006) freeway/ramp junctions are included in **Appendix A** of this report.

TABLE 2-4
EXISTING (2006) PEAK HOUR LEVEL-OF-SERVICE
FREEWAY / RAMP JUNCTIONS

Ramp Junction	2006 AM Peak Hour			2006 PM Peak Hour		
	Ramp Volume	Density	LOS	Ramp Volume	Density	LOS
1. Eastbound I-96 Off-ramp	125	21.9	C	90	15.5	B
2. Eastbound I-96 On-ramp	400	24.7	C	210	17.5	B
3. Westbound I-96 Off-ramp	125	13.9	B	360	25.1	C
4. Westbound I-96 On-ramp	85	14.8	B	105	22.9	C

Source: URS Corporation, September 2006

2.3 Future Conditions (2030)

2.3.1 Background Traffic Growth

Future-year (2030) traffic projections for the I-96/M-100 interchange were developed in consultation with MDOT staff and the Tri-County Regional Planning Commission (Tri-County RPC), the Metropolitan Planning Organization that services Clinton, Ingham, and Eaton Counties. Based on consultations the following annually-compounding growth rates were applied:

- 2.5%: Westbound I-96 on-ramp
- 2.0%: Eastbound and westbound I-96
- 1.5%: Grand River Avenue and M-100 south of Grand River Avenue
- 1.0%: Eastbound I-96 off-ramp and M-100 between Grand River Avenue and I-96
- 0.5%: Wright Road north of I-96, the eastbound I-96 on-ramp, and the westbound I-96 off-ramp

The future-year (2030) peak-hour volumes for the resulting No-Build Alternative are displayed on **Figure 2-3**.

2.3.2 No-Build Alternative (2030) Capacity Analysis

The future-year (2030) peak-hour Levels of Service for the I-96/M-100 signalized ramp terminal intersections are depicted in **Table 2-6** for the No-Build Alternative. As shown in Table 2-6, the M-100/Grand River Avenue intersection operates at LOS "F" during the morning and afternoon peak hours. A review of Figure 2-3, which depicts the LOS value associated with each individual turning movement for the No-Build Alternative, indicates that the long average control delays at the M-100/Grand River Avenue intersection primarily involve the westbound, southbound, and northbound approaches. Capacity analysis worksheets for all future-year (2030) signalized intersection capacity analyses are included in **Appendix B** of this report.

TABLE 2-6
FUTURE-YEAR (2030) PEAK HOUR LEVEL-OF-SERVICE
SIGNALIZED/UNSIGNALIZED INTERSECTIONS
NO-BUILD ALTERNATIVE

M-100 Intersection	Traffic Control	2006 AM Peak Hour		2006 PM Peak Hour	
		Level of Service	Control Delay (sec/veh)	Level of Service	Control Delay (sec/veh)
1. Eastbound I-96 off-ramp	Signal	B	15.8	B	13.5
2. Westbound I-96 off-ramp	Signal	B	15.8	B	17.9
3. Grand River Avenue	4-way STOP	F	81.4	F	88.1

Source: URS Corporation, September 2006

The future-year (2030) peak-hour Levels of Service for the basic freeway segments along I-96 within the study area are depicted in **Table 2-7** for the No-Build Alternative. As shown in Table 2-7, the basic freeway segments are anticipated to operate at acceptable Levels-of-Service during future-year (2030) peak hours, except eastbound I-96, east of M-100, which is anticipated to operate at Level-of-Service "E" during the morning peak hour, and westbound I-96, east and west of M-100, which is anticipated to operate at Level-of-Service "E" during the afternoon peak hour. These results indicate the freeway will be reaching its capacity within the next 20 to 25 years. Capacity analysis worksheets for all future-year (2030) basic freeway segment analyses are included in **Appendix B** of this report.

TABLE 2-7
FUTURE-YEAR (2030) PEAK HOUR LEVEL-OF-SERVICE
BASIC FREEWAY SEGMENTS
NO-BUILD ALTERNATIVE

I-96 Freeway Segment	2030 AM Peak Hour			2030 PM Peak Hour		
	Volume	Density	LOS	Volume	Density	LOS
Eastbound I-96						
1. West of M-100	3,625	34.2	D	2,570	21.6	C
2. East of M-100	3,915	40.2	E	2,665	22.4	C
Westbound I-96						
1. West of M-100	2,295	19.2	C	3,800	37.5	E
2. East of M-100	2,285	19.1	C	4,010	42.5	E

Source: URS Corporation, September 2006

The future-year (2030) peak-hour Levels-of-Service for the various freeway/ramp junctions at the I-96/M-100 interchange are depicted in **Table 2-8** for the No-Build Alternative. As shown in Table 2-8, the freeway/ramp junctions are anticipated to operate at acceptable Levels-of-Service during future-year (2030) peak hours, except the eastbound I-96 off-ramp and on-ramp, which are anticipated to operate at Level-of-Service "E" during the morning peak hour, and the westbound off-ramp and on-ramp, which operate at Level-of-Service "F" and "E", respectively, during the afternoon peak hour. The lack of capacity on the freeway is the cause of these poor ramp LOS values. Capacity analysis worksheets for all future-year (2030) freeway/ramp junctions are included in **Appendix B** of this report.

TABLE 2-8
FUTURE-YEAR (2030) PEAK HOUR LEVEL-OF-SERVICE
FREEWAY / RAMP JUNCTIONS
NO-BUILD ALTERNATIVE

Ramp Junction	2030 AM Peak Hour			2030 PM Peak Hour		
	Ramp Volume	Density	LOS	Ramp Volume	Density	LOS
1. Eastbound I-96 Off-ramp	175	36.3	E	165	25.7	C
2. Eastbound I-96 On-ramp	465	37.8	E	260	26.5	C
3. Westbound I-96 Off-ramp	155	22.8	C	410	40.2	F
4. Westbound I-96 On-ramp	165	23.2	C	200	36.9	E

Source: URS Corporation, September 2006

2.4 Environmental Screening

An environmental screening of the I-96/M-100 interchange and the area on Grand River Avenue at the MDOT Park-N-Ride (the area of the Relocated Eastbound Ramps Alternative) was conducted in April 2006. The purpose of the screening was to determine the existence, or potential for existence, of environmental features that would be impacted by the interchange alternatives described in Section 3 of this report. Any such features were noted and suggestions for follow-up investigations were made in the event that the preferred alternative might have the potential to impact the features or be impacted by the features. An in-depth investigation of any potential features by such means as wetland delineation, evaluation of the eligibility of a structure for inclusion on the National List of Historic Places, etc., was not completed as part of the environmental screening.

The general nature of the area studied is rural and lightly developed. No wetlands were visually noted in the project screening area, except in the area of the Relocated Eastbound Ramps Alternative. According to a database search provided by Environmental Data Resources, Inc. (EDR), there are no designated wilderness areas, wildlife preserves, threatened or endangered species, or designated critical habitats in the project screening area. No historic properties listed in the National List of Historic Places were identified in the project screening area, based on an online search of the Michigan Historic Sites database.

This bridge can be reconstructed under Categorical Exclusion, no special studies are needed.

2.4.1 Northeast Quadrant

The area in the northeast quadrant of the I-96/M-100 interchange is a cultivated field. A line of dense vegetation, including mature deciduous trees, lies between the field and the westbound I-96 off-ramp. The existing right-of-way between westbound I-96 and the westbound I-96 off-ramp contains grassy vegetation and small trees. No wetland vegetation was observed, and no environmental features or concerns were noted in this quadrant.

2.4.2 Northwest Quadrant

The area in the northwest quadrant of the I-96/M-100 interchange is a cultivated field. Adjacent to the westbound I-96 on-ramp is an area of light grassy vegetation and small trees. The existing right-of-way between westbound I-96 and the westbound I-96 on-ramp contains grassy vegetation and small trees. No wetlands were observed in the northwest quadrant and no environmental features or concerns were noted.

2.4.3 Southeast Quadrant

The area in the southeast quadrant of the I-96/M-100 interchange contains grassy vegetation and small trees. Commercial properties are present along M-100 and Grand River Avenue adjacent to the eastbound I-96 on-ramp. No wetland vegetation was observed, but an environmental database search identified several sites of potential environmental concern in the quadrant. Sites identified in the environmental database search are summarized below.

The former Jerry's Sunoco service station is located directly adjacent to the eastbound I-96 on-ramp. The site is listed as an open Leaking Underground Storage Tank (LUST) site indicating that petroleum contamination is present at this site. As such, due to the close proximity of the site to the project area, any reconstruction of the interchange or excavation near it may be impacted by this facility.

Rural Bottled Gas is located directly south of the former Jerry's Sunoco site on Grand River Avenue. Two registered aboveground storage tanks (AST) are currently located on this site. A Mobil gas station is located to the south of the Rural Bottled Gas site on Grand River Avenue. Registered underground storage tanks (UST) are documented at the site.

With the exception of the former Jerry's Sunoco site, there are no documented releases at any of the above sites. Current monitoring and reporting requirements imposed upon the owners and operators of underground storage tanks are stringent and should prevent or minimize large volume losses that have caused problems for construction projects in the past. Database information indicates that these sites are in compliance with these requirements.

MDOT has significant protections against the assumption of liability for contamination within the right-of-way that it owns or acquires. Prior to any construction that may impact the referenced sites or the right-of-way adjacent to these sites, it is recommended that the current status of these sites be reviewed by contacting the Michigan Department of Environmental Quality (MDEQ) Lansing District office. While liability protection for transportation right-of-way projects is provided by the Michigan Natural Resources and Environmental Protection Act (NREPA), there are potential health and safety issues for construction workers and the public that must be addressed if contaminated groundwater is encountered.

No other environmental features or concerns were noted in the southeast quadrant.

2.4.4 Southwest Quadrant

The area in the southwest quadrant of the I-96/M-100 interchange consists of a cultivated field located directly adjacent to the existing eastbound I-96 off-ramp, surrounded by trees and grassy vegetation.

A Speedway Service Station is located immediately south of the cultivated field on M-100. Four registered UST's are documented on this site. No releases are documented for the site and the site is not listed in the LUST database. Database information indicates that this site is in compliance with these requirements.

Directly west of the Speedway Service Station is a small pond. The pond and the surrounding area not identified as wetlands in the National Wetland Inventory maps. No other wet areas or other environmental features or concerns were noted in this quadrant.

2.4.5 Area of Relocated Eastbound Ramps Interchange Alternative

The Relocated Eastbound Ramps Interchange Alternative involves the relocation of the eastbound I-96 ramps to an area on Grand River Avenue east of M-100. An unpaved MDOT Park-N-Ride lot is currently located in this area. North of the parking lot is a large pond, with a large wetland area extending westward from the pond. The National Wetland Inventory (NWI) lists the entire area as a Palustine Broadleaved Deciduous Forested Wetland, Seasonally Flooded. At the time of the environmental screening, the area northwest, north, and northeast of the Park-N-Ride lot was largely flooded. Vegetation in this area includes grasses, wetland vegetation, and mature trees. Any impacts to a wetland would require a Part 3030 NREPA Wetlands permit and mitigation. It is recommended that the Regional MDOT Permit Coordinator be contacted early in the design process to provide wetland determinations and input to the design team to minimize any impacts to the wetland, minimize permit issues, and minimize mitigation needs.

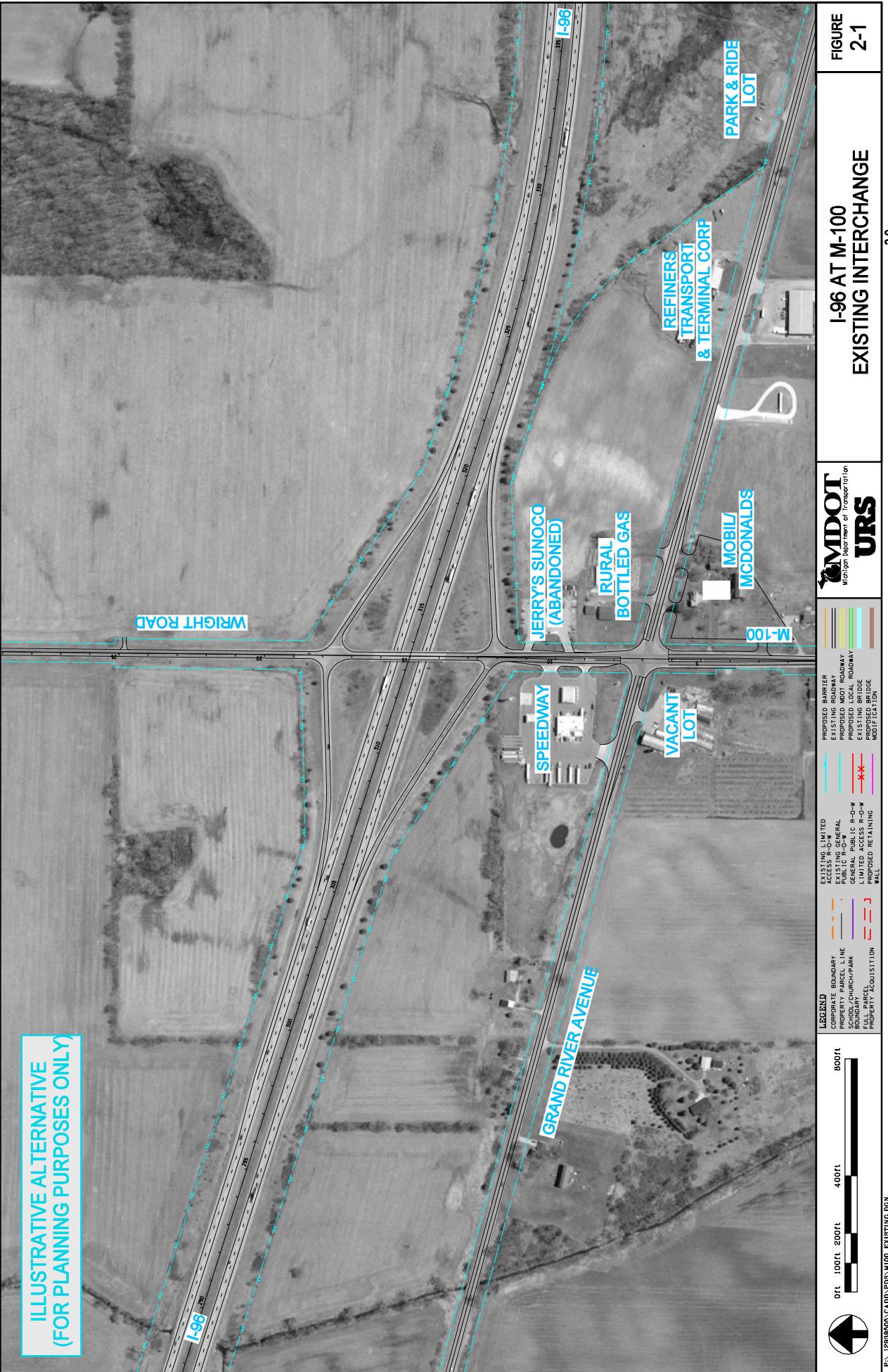
Directly west of the proposed ramp junction for the Relocated Eastbound Ramps Alternative, on Grand River Avenue, is a fill hauling company called Refiners Transport and Terminal Corporation. The site is listed in several of the environmental databases, including the Resource Conservation and Recovery Act (RCRA) Small-Quantity Generator, the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), and the UST and Facility Index System (FINDS) databases. The site is also listed as an open LUST site (Facility ID #00000650) indicating that petroleum contamination is present at the site.

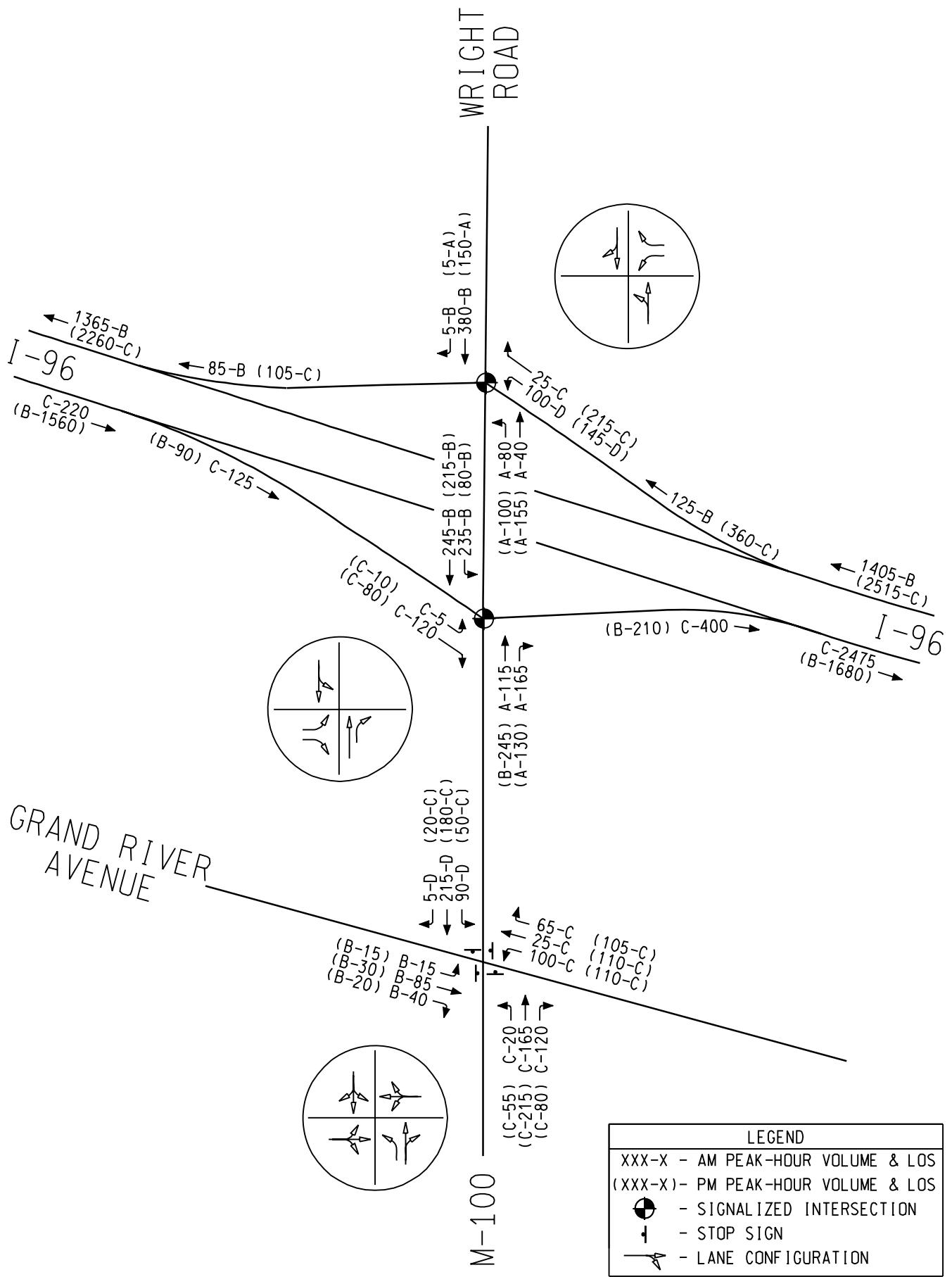
Prior to any construction that may affect the referenced sites or the right-of-way adjacent to these sites, it is recommended that the current status of these sites be reviewed by contacting the MDEQ Lansing District office.

2.5 Conclusions

Based on the results of the existing and No-Build conditions analyses, the following conclusions can be reached.

1. The I-96/M-100 interchange ramp terminal intersections, M-100/Grand River Avenue intersection, basic freeway segments, and freeway/ramp junctions operate at acceptable Levels of Service during existing (2006) peak hours. The existing bridge under-clearance and vertical profile do not meet current standards.
2. The M-100/Grand River Avenue intersection operates at Level-of-Service "F" during the morning and afternoon peak periods under future-year (2030) conditions. At some point, the existing four-way STOP will need to be replaced with a traffic signal.
3. Based on the environmental screening completed for the interchange, environmental mitigation may be necessary in the southeast quadrant of the interchange and in the area of the Relocated Eastbound Lanes Alternative, depending on the impacts posed by the alternatives presented in Section 3.

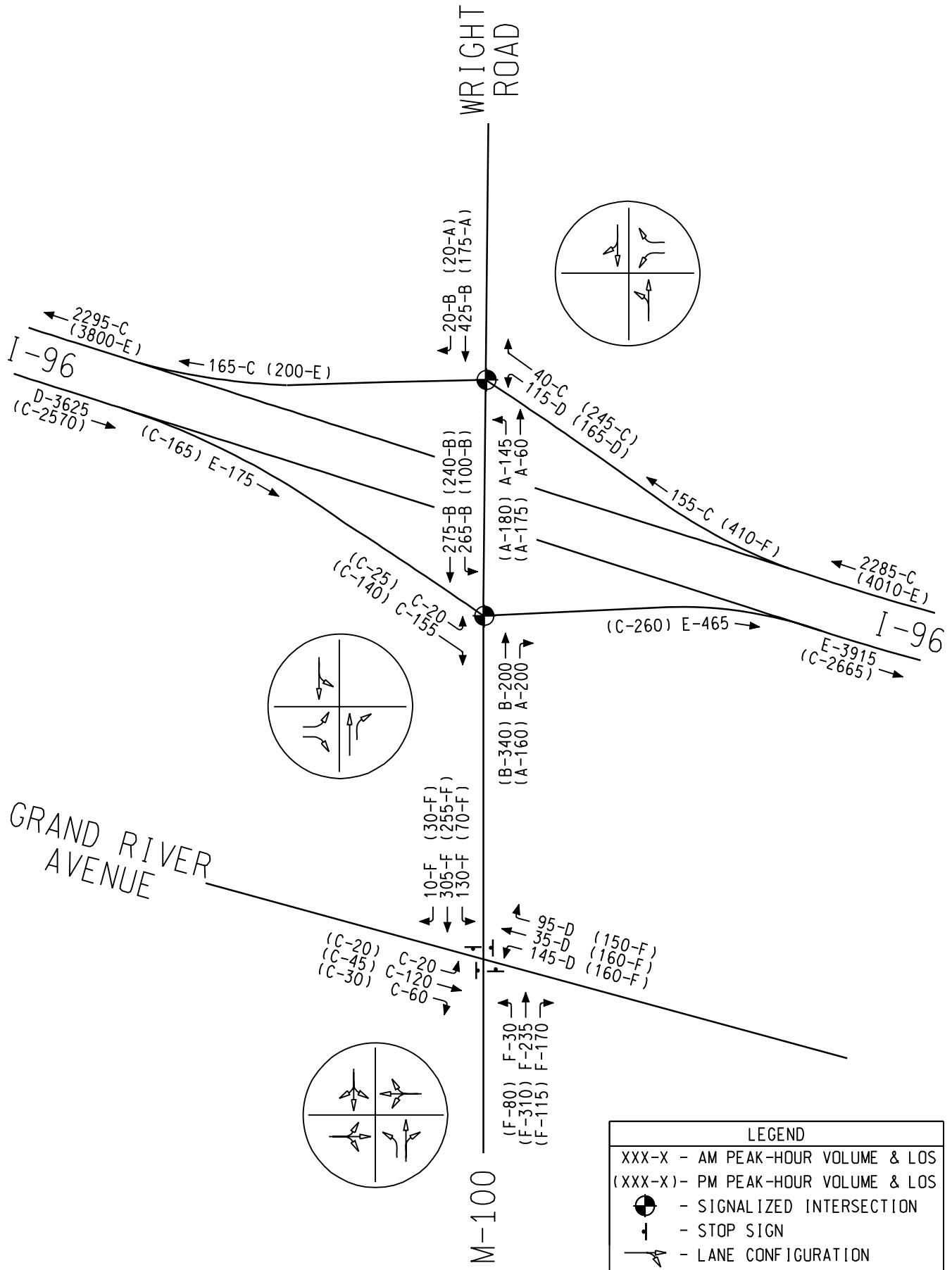




MDOT URS
Michigan Department of Transportation

EXISTING (2006) PEAK-HOUR TRAFFIC VOLUMES

**FIGURE
2-2**



 **MDOT** Michigan Department of Transportation **URS**

FUTURE (2030) NO-BUILD PEAK-HOUR TRAFFIC VOLUMES

FIGURE 2-3

3.0 ALTERNATIVES

3.1 Description of Alternatives

The following interchange concepts were examined in detail to determine the feasibility of replacing the existing I-96/M-100 tight-diamond interchange with an improved design that meets current geometric requirements and serves future-year (2030) traffic at an acceptable Level-of-Service.

3.1.1 Tight-Diamond Interchange Alternative

The first alternative consists of simply increasing the capacity of the existing tight-diamond interchange. Two variations of the Tight-diamond Interchange Alternative are depicted in **Figure 3-1** and **Figure 3-2**. As shown in these figures, the Tight-Diamond Interchange Alternative involves widening M-100 into a 3-lane section over I-96. A new bridge over I-96 with standard vertical clearance would provide one lane in each direction of M-100 and a two-way center left-turn lane.

Separate left- and right-turn lanes would be constructed on each off-ramp approach to M-100. A right-turn bay would be constructed at the eastbound I-96 ramp terminal intersection to provide additional capacity for the northbound-to-eastbound turn movement. The profile of M-100 over I-96 would be modified to improve sight distance, as shown in **Figure 3-3**.

As shown in Figure 3-1 and Figure 3-2, the difference between the two tight-diamond interchange variations is the alignment of the ramps. Figure 3-1 depicts Variation #1, a “spread” ramp treatment which improves intersection turning radii and truck operations at the ramp terminals, while Figure 3-2 depicts Variation #2, a standard tight-diamond interchange treatment (with skewed ramps, similar to the existing configuration).

For each variation, right-of-way acquisition would be necessary and along both sides of Wright Road north of the interchange because of the fill required to improve the vertical profile of M-100. As shown in Figure 3-1, right-of-way would also be needed in the northwest and southeast quadrants for the off-ramp improvements associated with Variation #1.

3.1.2 Partial Cloverleaf Interchange Alternative

The Partial Cloverleaf (Parclo) Interchange Alternative is shown in **Figure 3-4**. The Parclo Interchange Alternative involves the construction of a loop ramp in the northwest quadrant of the interchange. Significant right-of-way would need to be acquired in the northwest quadrant of the interchange in order to provide for the construction of the loop ramp.

The loop in the northwest quadrant would serve the westbound-to-southbound left-turn movement under STOP control. The westbound off-ramp would be located along the existing alignment and would serve the westbound-to-northbound right-turn movement under STOP control. The bridge over I-96 would be reconstructed to standard vertical clearance and carry three lanes of traffic. The profile of M-100 over I-96 would be modified to improve sight distance, as shown in **Figure 3-5**.

3.1.3 Modern Roundabout Alternative

The Modern Roundabout Alternative is shown in **Figure 3-6**. The Modern Roundabout Alternative involves the construction of a modern roundabout intersection at each ramp terminal. The existing off-ramps would be reconstructed to current standards and to allow for proper traffic flow into each roundabout intersection. The right-turning movements entering the roundabouts would operate under yield control. The bridge over I-96 would be reconstructed with

standard vertical clearance and carry two lanes of traffic—one through lane in each direction. The profile of M-100 over I-96 would be modified to improve sight distance as shown in Figure 3-3.

Small pieces of right-of-way would be necessary in the each of the four quadrants to provide acceptable geometry for the ramp terminal intersections. Right-of-way would also be necessary along both sides of Wright Road north of the interchange because of the fill required to improve the vertical profile.

3.1.4 Relocated Eastbound Ramps Alternative

The Relocated Eastbound Ramps Alternative is shown in **Figure 3-7**. The Relocated Eastbound Ramps Alternative involves relocating the eastbound I-96 ramps so they intersect Grand River Avenue approximately at the existing Park-N-Ride lot. The existing eastbound I-96 ramps would be removed. A two-way center left-turn lane would be constructed on Grand River Avenue from M-100 to the eastbound ramp terminal intersection. The westbound I-96 ramps would be constructed as shown in the Tight-Diamond Alternative. The bridge over I-96 would be reconstructed with standard vertical clearance and carry three lanes of traffic—one through lane in each direction and a two-way center left-turn lane. The profile of M-100 over I-96 would be modified to improve sight distance as shown in Figure 3-3.

Wetlands mitigation would likely be required for the Relocated Eastbound Ramps Alternative. Small pieces of right-of-way would be necessary in the southeast and northwest quadrants of the M-100/Grand River Avenue intersection to provide improved turning radii for truck traffic. Right-of-way would also be necessary along both sides of Wright Road north of the interchange because of the fill required to improve the vertical profile. MDOT owns the right-of-way along Grand River Avenue at the Park-N-Ride lot.

3.2 Evaluation of Alternatives

The evaluation of the alternatives consisted of comparing traffic operations and construction cost for the four “build” alternatives presented.

3.2.1 Traffic Operations

The projected future-year (2030) peak-hour traffic volumes are displayed on **Figure 3-8**, **Figure 3-9**, **Figure 3-10**, and **Figure 3-11** for the Tight-Diamond, Parclo Interchange, Modern Roundabout, and Relocated Eastbound Ramps Alternatives, respectively. Peak-hour capacity analyses of the various signalized and unsignalized ramp terminal intersections were completed for the morning and afternoon peak-hours. The Highway Capacity Manual does not account for the special operational characteristics of a modern roundabout as well as other software available, so RODEL software was used to provide geometric characteristics and capacity analysis results for the Modern Roundabout Alternative. Capacity analyses for basic freeway segments and freeway/ramp junctions were not completed, as the analyses were completed previously for the No-Build Alternative. The results of the capacity analyses are depicted in **Table 3-1** on the next page. Capacity analysis worksheets for the signalized intersections are included in **Appendix C** of this report for each alternative.

As shown in Table 3-1, the signalized ramp terminal intersections and unsignalized ramp terminal turning movements for each alternative are anticipated to operate at LOS “D” or better during future-year (2030) peak hours, except for the southbound approach of the relocated eastbound ramps intersection, which is anticipated to operate at LOS “E” during the morning peak hour. In addition, Figure 3-8, Figure 3-9, and Figure 3-11 each reveal that the individual traffic movements at each signalized ramp terminal intersection are anticipated to operate at LOS “D” or better during future-year (2030) conditions. Figure 3-10 reveals that each of the two proposed modern roundabout intersections are anticipated to operate with acceptable average vehicle delays. The alternatives presented in Figure 3-1, Figure

3-2, Figure 3-4, Figure 3-6, and Figure 3-7 each provide the necessary capacity at the ramp terminal intersections for future-year (2030) traffic conditions.

The M-100/Grand River Avenue intersection operates at LOS "F" under future-year (2030) peak hours for each of the alternatives under 4-way STOP control. The Level of Service of the M-100/Grand River Avenue improves to LOS "D" or better for each of the alternatives when modeled as a signalized intersection under future-year (2030) peak-hour conditions, as shown in Table 3-1.

TABLE 3-1
FUTURE-YEAR (2030) PEAK HOUR LEVEL-OF-SERVICE
SIGNALIZED AND UNSIGNALIZED INTERSECTIONS
BUILD ALTERNATIVES

M-100 Intersection	Traffic Control	2030 AM Peak Hour		2030 PM Peak Hour	
		Level of Service	Control Delay (sec/veh)	Level of Service	Control Delay (sec/veh)
Tight-Diamond Interchange Alternative					
1. Westbound I-96 off-ramp	Signal	B	17.7	B	10.5
2. Eastbound I-96 off-ramp	Signal	B	11.1	B	10.8
3. Grand River Avenue	4-Way STOP	F	81.4	F	**
	Signal	B	13.5	B	13.1
Parclo Interchange Alternative					
1. Westbound I-96 off-ramp	2-Way STOP	A	9.9	C	16.0
2. Westbound I-96 loop ramp	2-Way STOP	B	12.6	B	10.4
3. Eastbound I-96 off-ramp	Signal	B	10.1	B	10.5
	4-Way STOP	F	60.6	F	88.1
	Signal	B	12.7	B	12.1
Modern Roundabout Alternative *					
1. Westbound I-96 off-ramp	Roundabout	A	5.0	A	7.7
2. Eastbound I-96 off-ramp	Roundabout	A	8.4	A	7.4
3. Grand River Avenue	4-Way STOP	F	81.4	F	**
	Signal	B	13.5	B	13.1
Relocated Eastbound Ramps Alternative					
1. Westbound I-96 off-ramp	Signal	B	14.4	B	12.2
2. Eastbound I-96 off-ramp/ Grand River Avenue	2-Way STOP	E	35.3	C	16.5
	4-Way STOP	F	114.3	F	**
3. Grand River Avenue	Signal	D	50.9	C	32.1

* RODEL software, which was utilized to develop delay estimates for the Modern Roundabout Alternative, does not provide levels of service directly comparable to those provided by the HCM.

Source: URS Corporation, September 2006

** Control Delay exceeds 120 seconds.

3.2.2 Project Cost

Construction estimates were also generated for each of the alternatives for comparison. The detailed estimates of construction cost are shown in **Appendix D**, while the overall results are shown in **Table 3-2** on the next page for each alternative.

TABLE 3-2
PRELIMINARY CONSTRUCTION COST ESTIMATES
BUILD ALTERNATIVES

Alternative	Construction	Right-of-Way	PE + CE	TOTAL
1. Tight Diamond Interchange Alternative, Variation #1	\$8.54 million	\$ 320,000	\$940,000	\$ 9,800,000
2. Tight-Diamond Interchange Alternative, Variation #2	\$7.12 million	\$ 210,000	\$785,000	\$ 8,120,000
2. Parclo Interchange Alternative	\$8.59 million	n/a	\$945,000	\$ 9,540,000 *
3. Modern Roundabout Alternative	\$6.68 million	\$ 270,000	\$735,000	\$ 7,690,000
4. Relocated Eastbound Ramps Alternative	\$9.60 million	n/a	\$1.06 Million	\$ 10,700,000 *

*: Total cost does not include Right-of-Way costs

Source: URS Corporation, September 2006

As shown in Table 3-2, the Relocated Eastbound Ramps Alternative and Parclo Interchange Alternative result in the greatest construction costs (and overall costs for these alternatives would be even greater if right-of-way costs were incorporated). The Modern Roundabout Alternative is the least expensive alternative from a construction cost viewpoint.

3.3 Conclusions and Recommendations

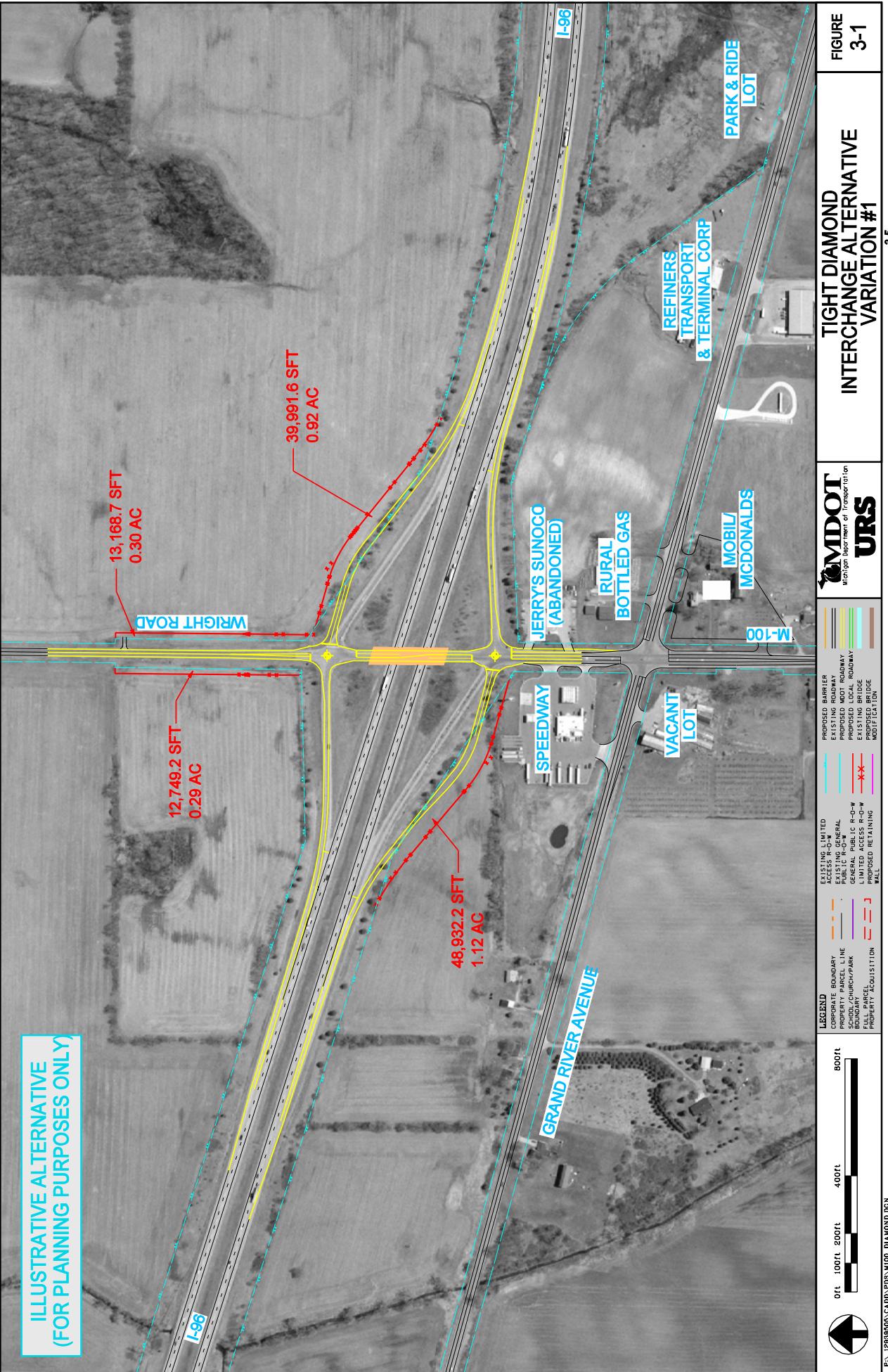
The Tight-Diamond Interchange Alternative provides acceptable LOS values for the various traffic movements within the interchange. The proposed ramps provide improved acceleration and deceleration lengths. A three-lane bridge is necessary to provide storage for the northbound-to-westbound and southbound-to-eastbound left-turn movements. The two variations examined require right-of-way along Wright Road north of I-96. Additional right-of-way is necessary for the Tight-Diamond Interchange Alternative (Variation #1) to reduce the skew of the existing ramp terminal intersections.

The Parclo Interchange Alternative provides acceptable LOS values under future-year peak-hour conditions, with LOS "C" or better for each of the signalized and unsignalized ramp terminal intersections. The Parclo Interchange Alternative suffers from high construction costs. Right-of-way costs are not known for the Parclo Interchange Alternative, but significant right-of-way acquisition is required.

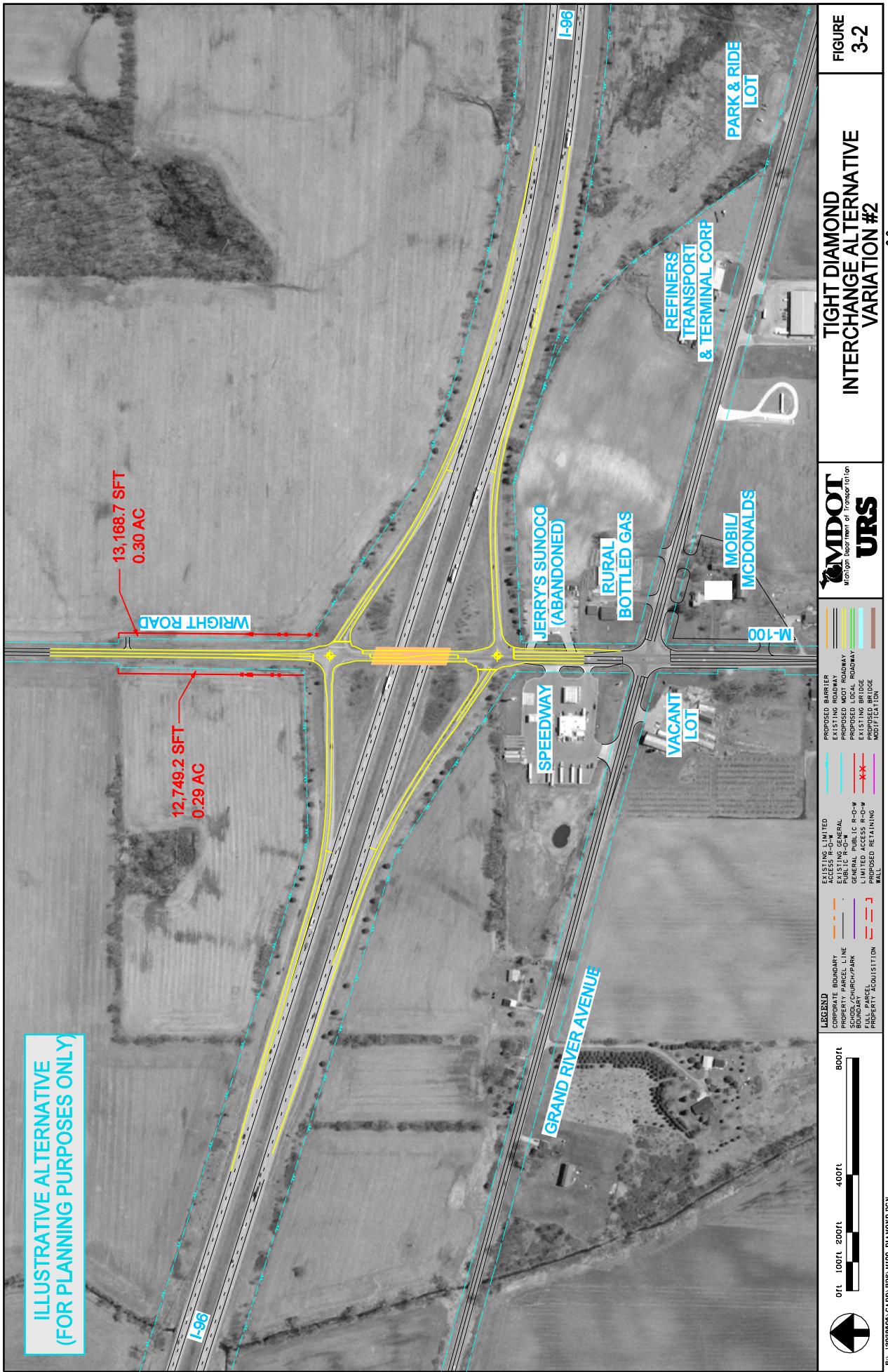
The Modern Roundabout Alternative provides acceptable LOS values for the various traffic movements within the interchange. Additionally, the Modern Roundabout Alternative can be constructed with very little right-of-way acquisition. The Modern Roundabout Alternative is the least expensive alternative, as it requires only a two-lane bridge.

The Relocated Eastbound Ramps Alternative provides acceptable traffic operations, as each traffic movement operates at LOS "C" or better. The Relocated Eastbound Ramps Alternative requires significant right-of-way acquisition and may impact a wetland area. The Relocated Eastbound Ramps Alternative has the highest construction costs due to roadwork involved on Grand River Avenue. Right-of-way costs are not known for the Relocated Eastbound Ramps Alternative, but significant right-of-way acquisition is required.

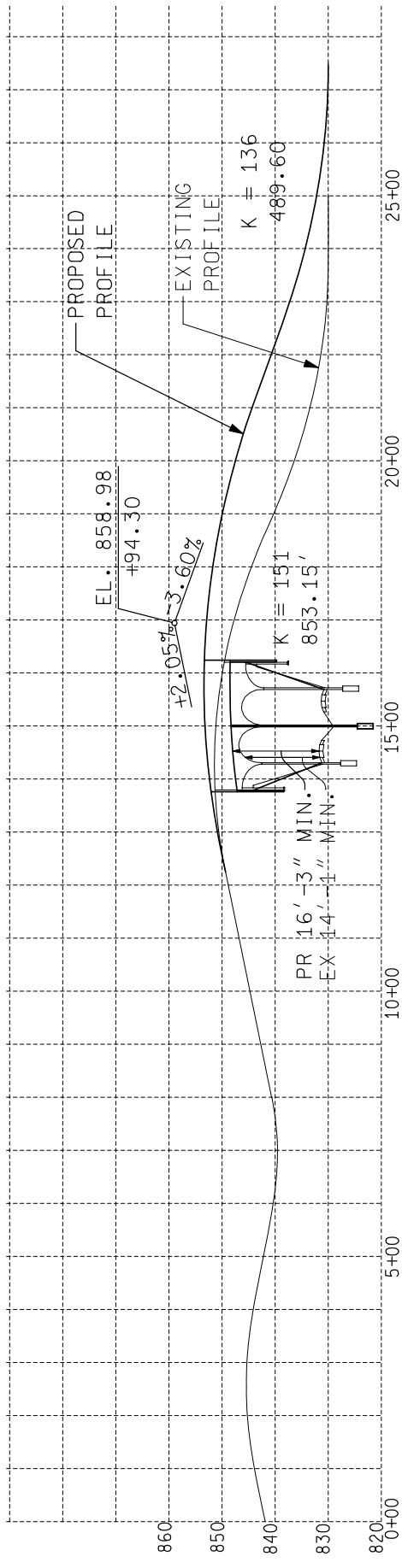
Based on the analyses completed herein, it is recommended that MDOT pursue the Tight-Diamond Interchange Alternative (Variation #2). The Tight-Diamond Interchange Alternative (Variation #2) can be constructed to the latest road and bridge design standards with minimal right-of-way expenses. While the Modern Roundabout Alternative costs less, it may not be favorable given that not enough information is available to determine how the Modern Roundabout Alternative would be affected by the possible future signalization of the M-100/Grand River Avenue intersection.



**ILLUSTRATIVE ALTERNATIVE
(FOR PLANNING PURPOSES ONLY)**



**ILLUSTRATIVE ALTERNATIVE
(FOR PLANNING PURPOSES ONLY)**

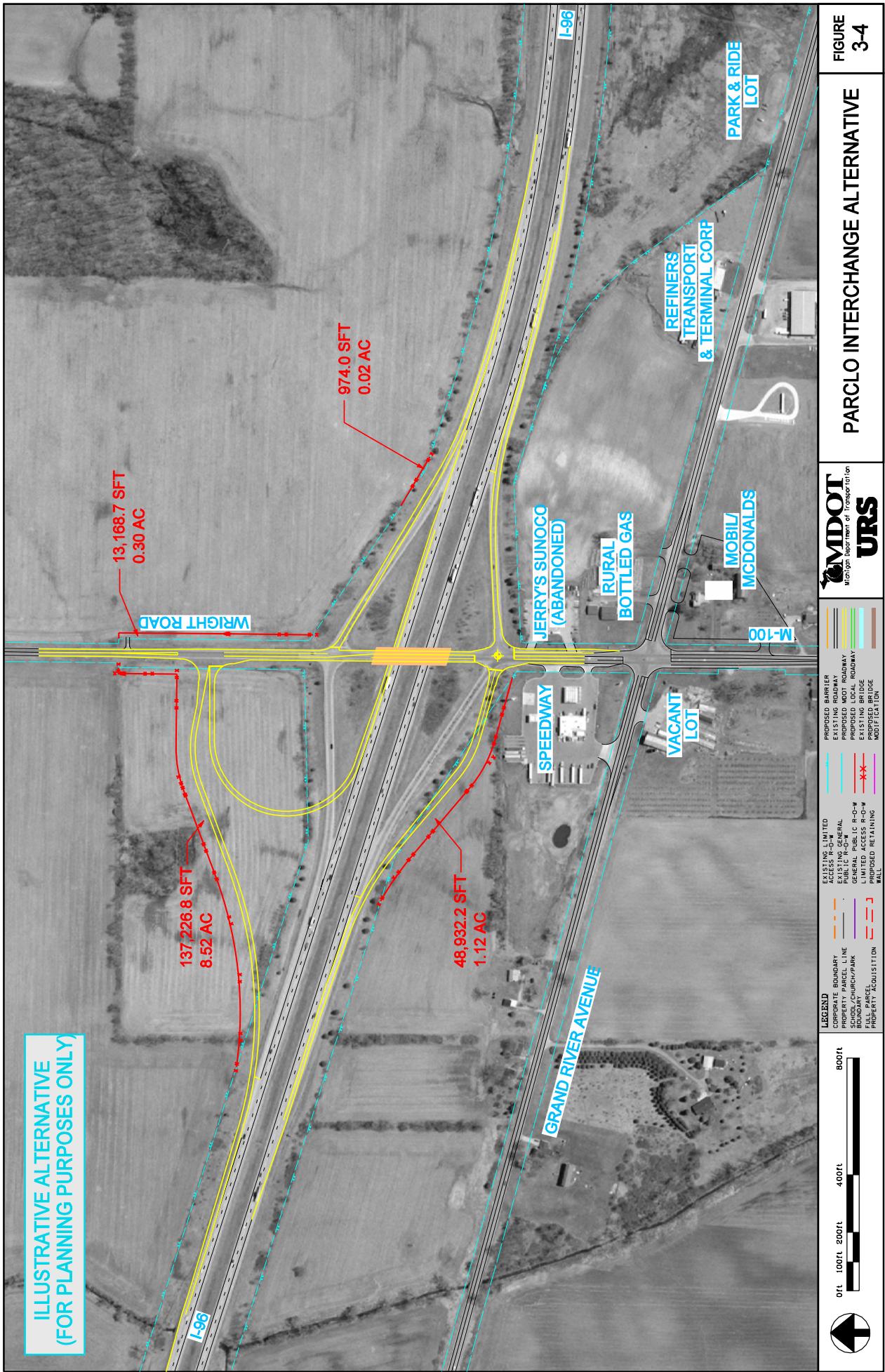


PROPOSED M-100 PROFILE

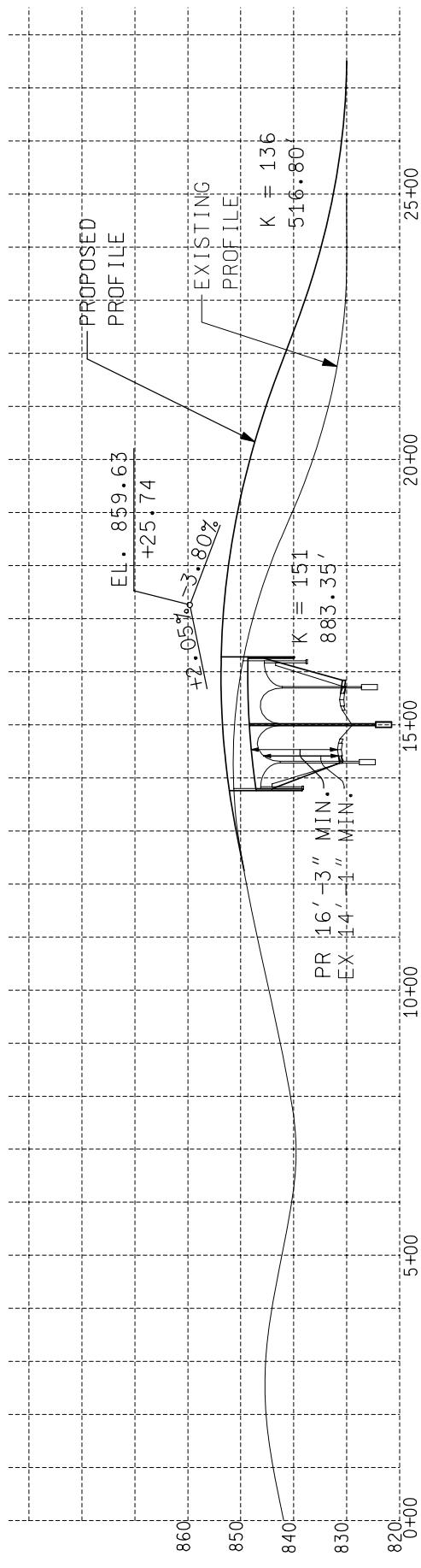
NOTE: NO WORK IS PROPOSED ON I-96.

 MDOT <small>Michigan Department of Transportation</small>	I-96 AT M-100 EXISTING AND PROPOSED VERTICAL PROFILES DIAMOND AND ROUNDABOUT ALTERNATIVES\$	FIGURE 3-3 <small>3-7</small>
<small>P:\12339303\CA00\PDS\M100 PROFILE2.DCN</small>		

ILLUSTRATIVE ALTERNATIVE
(FOR PLANNING PURPOSES ONLY)



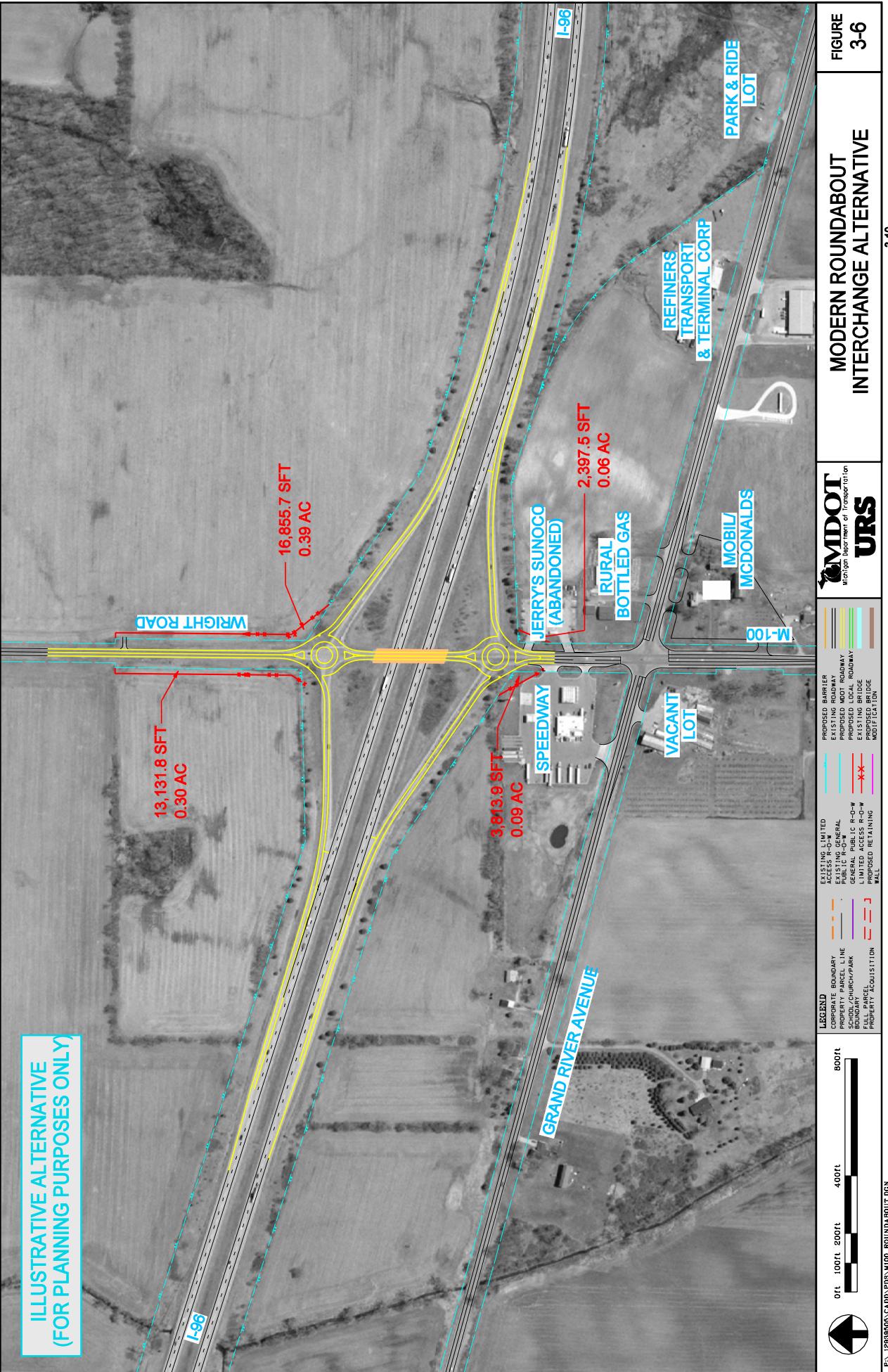
**ILLUSTRATIVE ALTERNATIVE
(FOR PLANNING PURPOSES ONLY)**

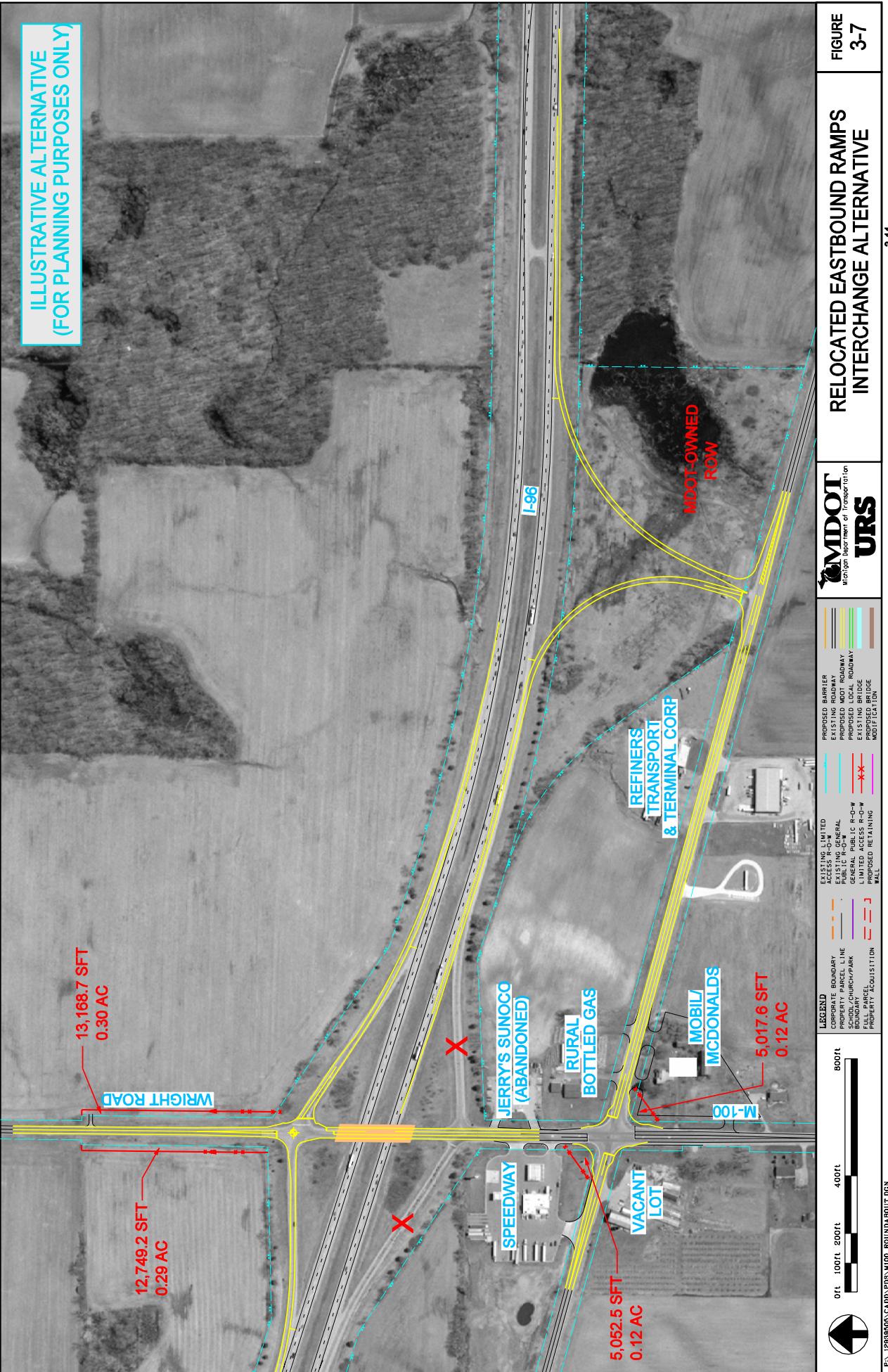


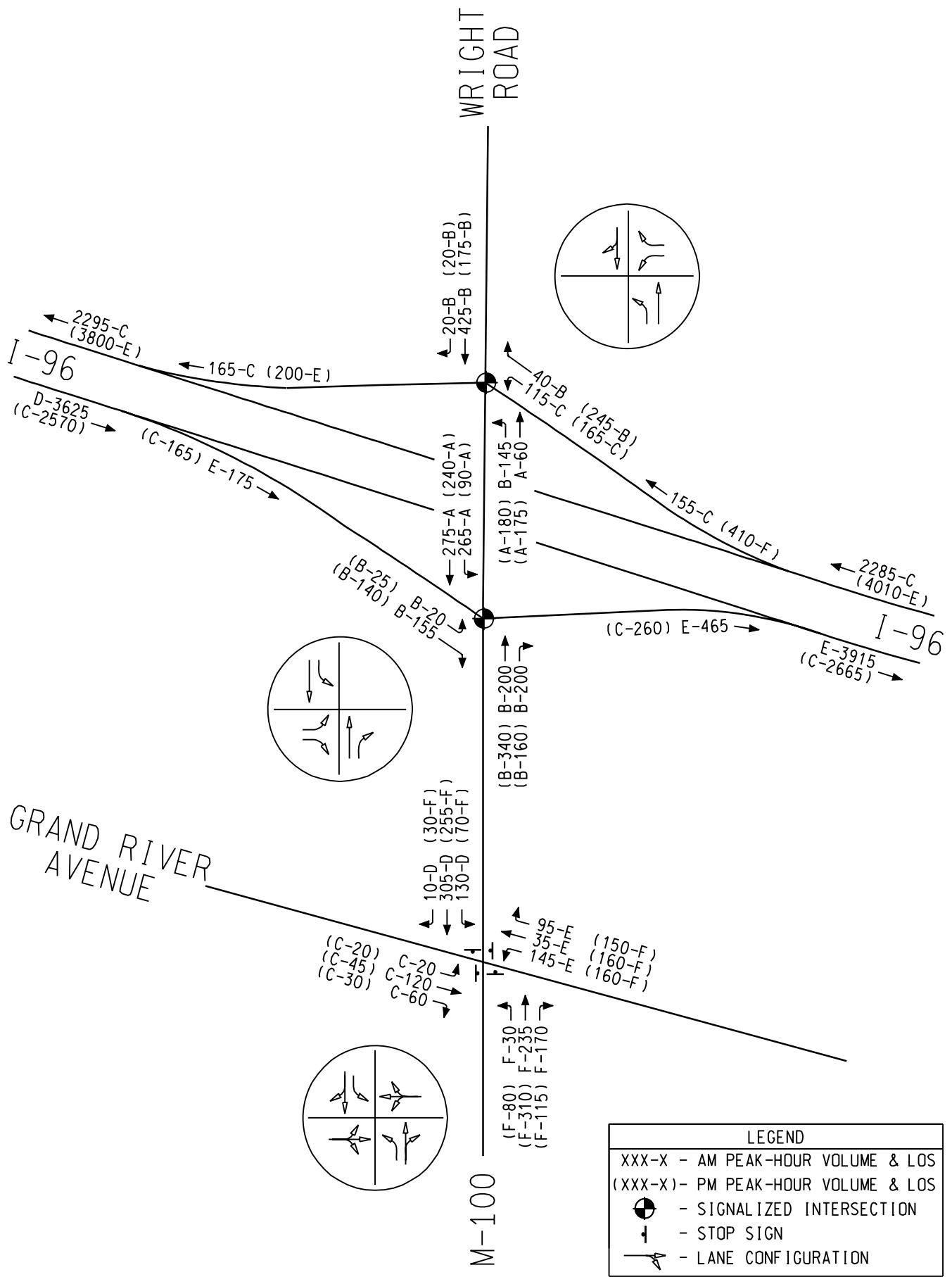
PROPOSED M-100 PROFILE

NOTE: NO WORK IS PROPOSED ON I-96.

 MDOT Michigan Department of Transportation	I-96 AT M-100 EXISTING AND PROPOSED VERTICAL PROFILES PARCLO ALTERNATIVE	FIGURE 3-5 <small>3-9</small>
<small>P:\12239303\CA00\PDS\M100 PROFILE2.DCN</small>		





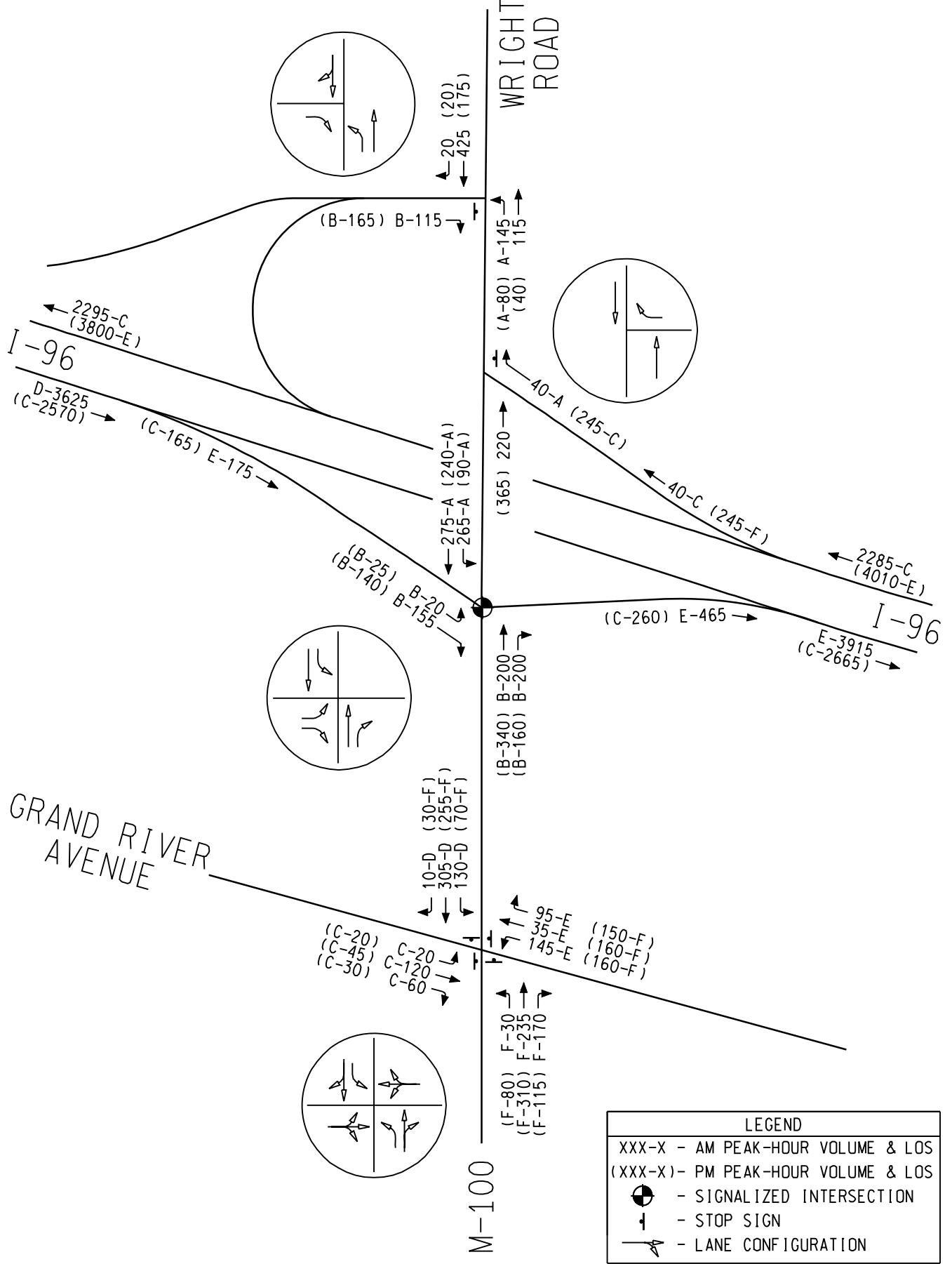


MDOT
Michigan Department of Transportation

URS

FUTURE (2030) PEAK-HOUR TRAFFIC VOLUMES AND LOS-TIGHT DIAMOND INTERCHANGE ALTERNATIVE

**FIGURE
3-8**



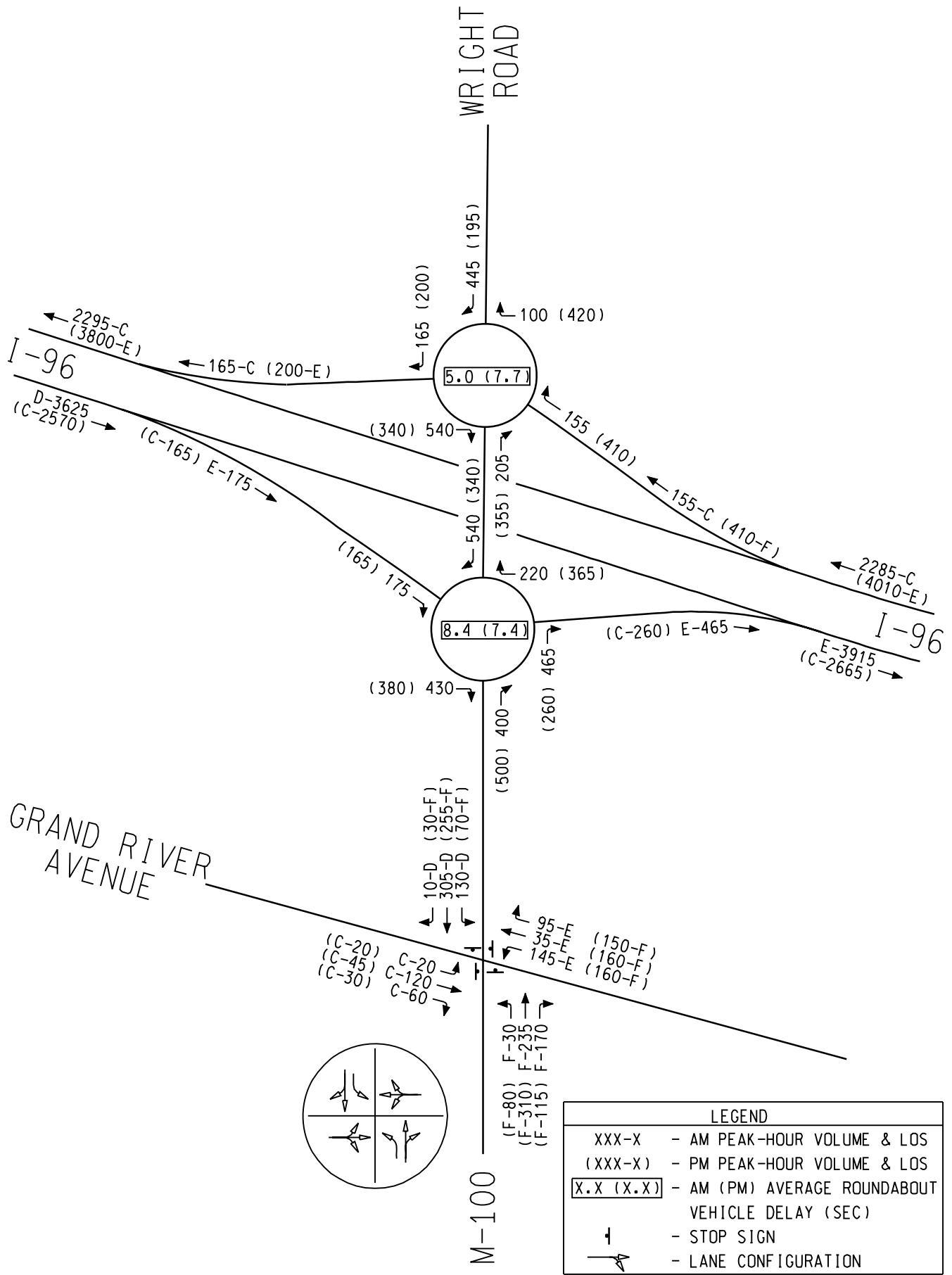
LEGEND	
XXX-X	- AM PEAK-HOUR VOLUME & LOS
(XXX-X)	- PM PEAK-HOUR VOLUME & LOS
●	- SIGNALIZED INTERSECTION
↓	- STOP SIGN
→	- LANE CONFIGURATION



MDOT URS
Michigan Department of Transportation

FUTURE (2030) PEAK-HOUR TRAFFIC
VOLUMES AND LOS-PARCLO
INTERCHANGE ALTERNATIVE

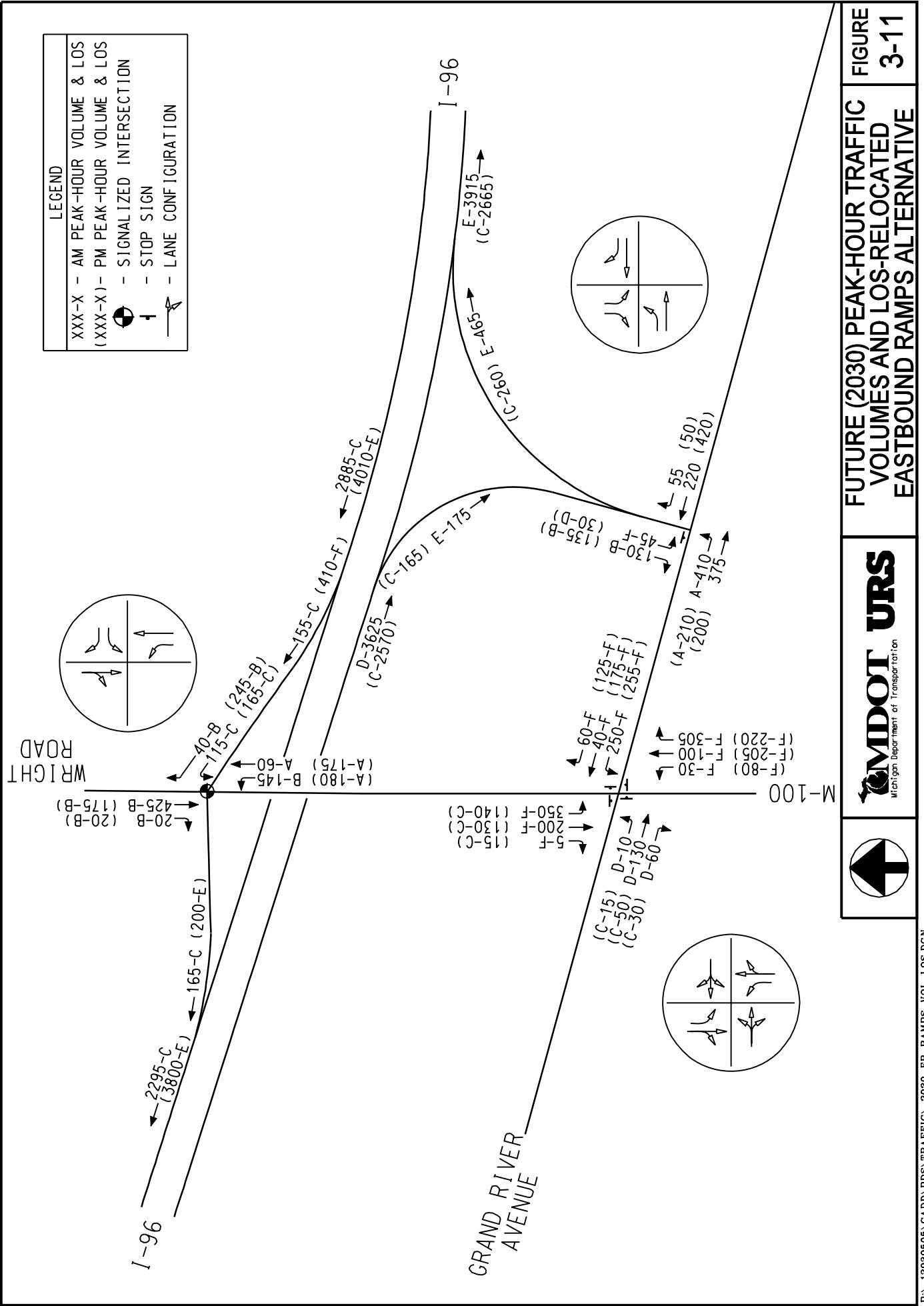
FIGURE
3-9



MDOT URS
Michigan Department of Transportation

FUTURE (2030) PEAK-HOUR TRAFFIC VOLUMES AND LOS-MODERN ROUNDABOUT ALTERNATIVE

**FIGURE
3-10**



Appendix A

Existing Conditions (2006) Capacity Analysis Worksheets

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0		4.0		4.0			4.0
Lane Util. Factor					1.00		1.00		1.00			1.00
Fr _t					1.00		0.85		1.00			1.00
Flt Protected					0.95		1.00		0.97			1.00
Satd. Flow (prot)					1597		1615		1705			1857
Flt Permitted					0.95		1.00		0.67			1.00
Satd. Flow (perm)					1597		1615		1182			1857
Volume (vph)	0	0	0	100	0	25	80	40	0	0	380	5
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.92	0.69	0.79	0.63	0.92	0.92	0.88	0.42
Adj. Flow (vph)	0	0	0	137	0	36	101	63	0	0	432	12
RTOR Reduction (vph)	0	0	0	0	0	30	0	0	0	0	1	0
Lane Group Flow (vph)	0	0	0	137	0	6	0	164	0	0	443	0
Heavy Vehicles (%)	2%	2%	2%	13%	0%	0%	10%	5%	0%	2%	2%	0%
Turn Type												
Protected Phases					6		6	3	3	8		4
Permitted Phases								8				
Actuated Green, G (s)					9.2		9.2		44.4			34.2
Effective Green, g (s)					11.0		11.0		47.0			36.0
Actuated g/C Ratio					0.16		0.16		0.67			0.51
Clearance Time (s)					5.8		5.8					5.8
Lane Grp Cap (vph)					251		254		876			955
v/s Ratio Prot					c0.09		0.00	c0.03			c0.24	
v/s Ratio Perm								0.10				
v/c Ratio					0.55		0.02	0.19			0.46	
Uniform Delay, d1					27.2		25.0	4.3			10.8	
Progression Factor					1.00		1.00	0.50			1.00	
Incremental Delay, d2					8.3		0.2	0.5			1.6	
Delay (s)					35.5		25.1	2.6			12.5	
Level of Service					D		C	A			B	
Approach Delay (s)	0.0				33.3			2.6			12.5	
Approach LOS	A				C			A			B	
Intersection Summary												
HCM Average Control Delay	15.0				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.43											
Actuated Cycle Length (s)	70.0				Sum of lost time (s)			12.0				
Intersection Capacity Utilization	42.4%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

2: EB I-96 off-ramp & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0		4.0	
Lane Util. Factor	1.00			1.00				1.00	1.00		1.00	
Fr _t	1.00			0.85				1.00	0.85		1.00	
Flt Protected	0.95			1.00				1.00	1.00		0.97	
Satd. Flow (prot)	1805			1380				1712	1417		1774	
Flt Permitted	0.95			1.00				1.00	1.00		0.77	
Satd. Flow (perm)	1805			1380				1712	1417		1395	
Volume (vph)	5	0	120	0	0	0	0	115	165	235	245	0
Peak-hour factor, PHF	0.50	0.92	0.82	0.92	0.92	0.92	0.92	0.90	0.87	0.75	0.88	0.92
Adj. Flow (vph)	10	0	146	0	0	0	0	128	190	313	278	0
RTOR Reduction (vph)	0	0	123	0	0	0	0	0	92	0	0	0
Lane Group Flow (vph)	10	0	23	0	0	0	0	128	98	0	591	0
Heavy Vehicles (%)	0%	2%	17%	2%	2%	2%	2%	11%	14%	2%	7%	2%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	9.2		9.2					35.2	35.2		43.4	
Effective Green, g (s)	11.0		11.0					36.0	36.0		47.0	
Actuated g/C Ratio	0.16		0.16					0.51	0.51		0.67	
Clearance Time (s)	5.8		5.8					4.8	4.8			
Lane Grp Cap (vph)	284		217					880	729		996	
v/s Ratio Prot	0.01		c0.02					0.07			c0.09	
v/s Ratio Perm									0.07		c0.31	
v/c Ratio	0.04		0.11					0.15	0.13		0.59	
Uniform Delay, d1	25.0		25.3					8.9	8.9		6.3	
Progression Factor	1.00		1.00					1.00	1.00		1.74	
Incremental Delay, d2	0.2		1.0					0.3	0.4		2.3	
Delay (s)	25.2		26.3					9.3	9.3		13.2	
Level of Service	C		C					A	A		B	
Approach Delay (s)		26.2			0.0			9.3			13.2	
Approach LOS		C			A			A			B	
Intersection Summary												
HCM Average Control Delay		14.0		HCM Level of Service				B				
HCM Volume to Capacity ratio		0.50										
Actuated Cycle Length (s)		70.0		Sum of lost time (s)				12.0				
Intersection Capacity Utilization		45.1%		ICU Level of Service				A				
Analysis Period (min)		15										
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	15	85	40	100	25	65	20	165	120	90	215	5
Peak Hour Factor	0.70	0.98	0.58	0.73	0.79	0.79	0.63	0.77	0.77	0.73	0.78	0.25
Hourly flow rate (vph)	21	87	69	137	32	82	32	214	156	123	276	20
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total (vph)	177	251	32	370	123	296						
Volume Left (vph)	21	137	32	0	123	0						
Volume Right (vph)	69	82	0	156	0	20						
Hadj (s)	-0.08	0.11	0.58	-0.18	0.70	0.03						
Departure Headway (s)	6.9	6.9	7.4	6.7	7.5	6.9						
Degree Utilization, x	0.34	0.48	0.07	0.68	0.26	0.56						
Capacity (veh/h)	450	468	460	517	453	493						
Control Delay (s)	13.5	16.0	9.8	21.6	12.0	17.1						
Approach Delay (s)	13.5	16.0	20.7		15.6							
Approach LOS	B	C	C		C							
Intersection Summary												
Delay					17.0							
HCM Level of Service					C							
Intersection Capacity Utilization				52.9%		ICU Level of Service				A		
Analysis Period (min)				15								

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0		4.0			4.0	
Lane Util. Factor				1.00		1.00		1.00			1.00	
Fr _t				1.00		0.85		1.00			0.99	
Flt Protected				0.95		1.00		0.98			1.00	
Satd. Flow (prot)				1736		1615		1851			1842	
Flt Permitted				0.95		1.00		0.84			1.00	
Satd. Flow (perm)				1736		1615		1589			1842	
Volume (vph)	0	0	0	145	0	215	100	155	0	0	150	5
Peak-hour factor, PHF	0.92	0.92	0.92	0.84	0.25	0.86	0.91	0.84	0.92	0.92	0.91	0.50
Adj. Flow (vph)	0	0	0	173	0	250	110	185	0	0	165	10
RTOR Reduction (vph)	0	0	0	0	0	211	0	0	0	0	3	0
Lane Group Flow (vph)	0	0	0	173	0	39	0	295	0	0	172	0
Heavy Vehicles (%)	2%	2%	2%	4%	2%	0%	2%	0%	0%	0%	1%	25%
Turn Type												
Protected Phases				Prot		custom	custom					
Permitted Phases					6		6	3	3	8		4
Actuated Green, G (s)					9.2		9.2		44.4			34.2
Effective Green, g (s)					11.0		11.0		47.0			36.0
Actuated g/C Ratio					0.16		0.16		0.67			0.51
Clearance Time (s)					5.8		5.8					5.8
Lane Grp Cap (vph)					273		254		1108			947
v/s Ratio Prot					c0.10		0.02		c0.04			0.09
v/s Ratio Perm									c0.14			
v/c Ratio					0.63		0.15		0.27			0.18
Uniform Delay, d1					27.6		25.5		4.6			9.1
Progression Factor					1.00		1.00		0.30			1.00
Incremental Delay, d2					10.7		1.3		0.6			0.4
Delay (s)					38.3		26.8		1.9			9.5
Level of Service					D		C		A			A
Approach Delay (s)	0.0					31.5			1.9			9.5
Approach LOS	A					C			A			A
Intersection Summary												
HCM Average Control Delay	17.4				HCM Level of Service				B			
HCM Volume to Capacity ratio	0.34											
Actuated Cycle Length (s)	70.0				Sum of lost time (s)				12.0			
Intersection Capacity Utilization	44.2%				ICU Level of Service				A			
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

2: EB I-96 off-ramp & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0		4.0	
Lane Util. Factor	1.00			1.00				1.00	1.00		1.00	
Fr _t	1.00			0.85				1.00	0.85		1.00	
Flt Protected	0.95			1.00				1.00	1.00		0.99	
Satd. Flow (prot)	1805			1599				1863	1538		1759	
Flt Permitted	0.95			1.00				1.00	1.00		0.84	
Satd. Flow (perm)	1805			1599				1863	1538		1502	
Volume (vph)	10	0	80	0	0	0	0	245	130	80	215	0
Peak-hour factor, PHF	0.55	0.92	0.79	0.92	0.92	0.92	0.92	0.95	0.85	0.72	0.84	0.92
Adj. Flow (vph)	18	0	101	0	0	0	0	258	153	111	256	0
RTOR Reduction (vph)	0	0	85	0	0	0	0	0	74	0	0	0
Lane Group Flow (vph)	18	0	16	0	0	0	0	258	79	0	367	0
Heavy Vehicles (%)	0%	0%	1%	0%	0%	0%	0%	2%	5%	12%	4%	0%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	9.2		9.2					35.2	35.2		43.4	
Effective Green, g (s)	11.0		11.0					36.0	36.0		47.0	
Actuated g/C Ratio	0.16		0.16					0.51	0.51		0.67	
Clearance Time (s)	5.8		5.8					4.8	4.8			
Lane Grp Cap (vph)	284		251					958	791		1049	
v/s Ratio Prot	c0.01		0.01					0.14			c0.05	
v/s Ratio Perm									0.05		c0.18	
v/c Ratio	0.06		0.06					0.27	0.10		0.35	
Uniform Delay, d1	25.1		25.1					9.6	8.7		4.9	
Progression Factor	1.00		1.00					1.00	1.00		2.11	
Incremental Delay, d2	0.4		0.5					0.7	0.3		0.8	
Delay (s)	25.5		25.6					10.3	9.0		11.3	
Level of Service	C		C					B	A		B	
Approach Delay (s)		25.6			0.0			9.8			11.3	
Approach LOS		C			A			A			B	
Intersection Summary												
HCM Average Control Delay		12.5		HCM Level of Service				B				
HCM Volume to Capacity ratio		0.30										
Actuated Cycle Length (s)		70.0		Sum of lost time (s)				12.0				
Intersection Capacity Utilization		42.0%		ICU Level of Service				A				
Analysis Period (min)		15										
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

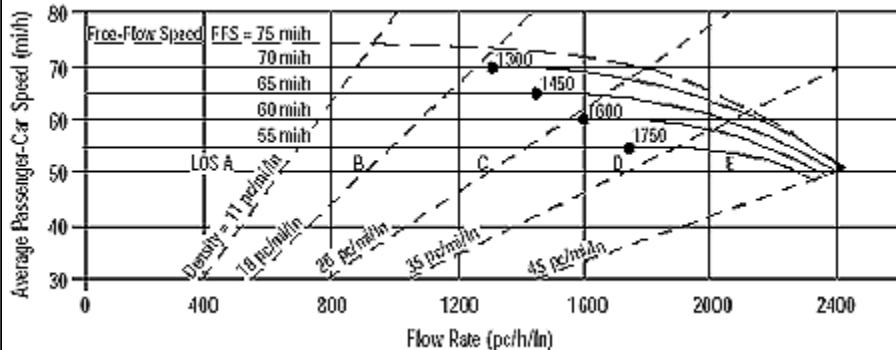
3: Grand River Ave & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	15	30	20	110	110	105	55	215	80	50	180	20
Peak Hour Factor	0.60	0.65	0.79	0.74	0.74	0.90	0.70	0.81	0.84	0.74	0.92	0.64
Hourly flow rate (vph)	25	46	25	149	149	117	79	265	95	68	196	31
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total (vph)	96	414	79	361	68	227						
Volume Left (vph)	25	149	79	0	68	0						
Volume Right (vph)	25	117	0	95	0	31						
Hadj (s)	0.05	-0.05	0.50	-0.17	0.64	-0.07						
Departure Headway (s)	7.2	6.2	7.4	6.7	7.8	7.0						
Degree Utilization, x	0.19	0.72	0.16	0.67	0.15	0.44						
Capacity (veh/h)	416	414	468	515	431	469						
Control Delay (s)	11.9	23.3	10.6	20.9	10.9	14.3						
Approach Delay (s)	11.9	23.3	19.1		13.5							
Approach LOS	B	C	C		B							
Intersection Summary												
Delay							18.6					
HCM Level of Service							C					
Intersection Capacity Utilization				54.5%			ICU Level of Service				A	
Analysis Period (min)							15					

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information

Analyst MJW
 Agency or Company URS CORPORATION
 Date Performed 01/23/2006
 Analysis Time Period AM PEAK
 Project Description I-96/M-100 INTERCHANGE STUDY

Site Information

Highway/Direction of Travel EB I-96
 From/To WEST OF M-100
 Jurisdiction CLINTON COUNTY
 Analysis Year 2006

Oper.(LOS)

Des.(N)

Planning Data

Flow Inputs

Volume, V	2200 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

Lane Width	12.0	ft	f_{LW}	mi/h	
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	mi/h	
Interchange Density	0.50	l/mi	f_{ID}	mi/h	
Number of Lanes, N	2		f_N	mi/h	
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

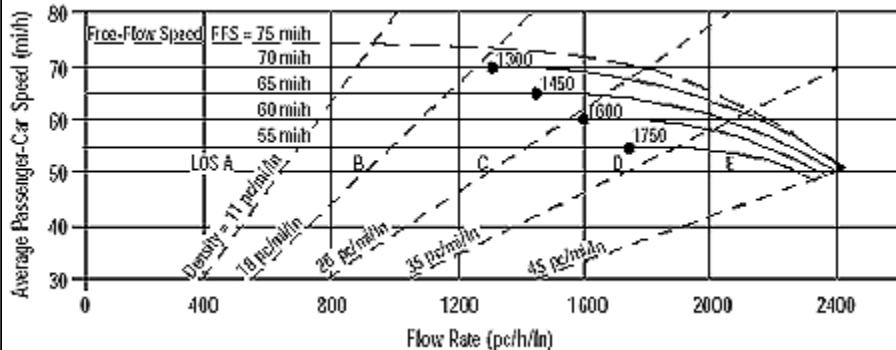
LOS and Performance Measures

Operational (LOS)			Design (N)	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	1289	pc/h/ln	Design LOS	
S	70.0	mi/h	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	pc/h
$D = v_p / S$	18.4	pc/mi/ln	S	mi/h
LOS	C		$D = v_p / S$	pc/mi/ln
			Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information

Analyst MJW
 Agency or Company URS CORPORATION
 Date Performed 01/23/2006
 Analysis Time Period AM PEAK
 Project Description I-96/M-100 INTERCHANGE STUDY

Site Information

Highway/Direction of Travel EB I-96
 From/To EAST OF M-100
 Jurisdiction CLINTON COUNTY
 Analysis Year 2006

Oper.(LOS)

Des.(N)

Planning Data

Flow Inputs

Volume, V	2475 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

Lane Width	12.0	ft	f_{LW}	mi/h	
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	mi/h	
Interchange Density	0.50	I/mi	f_{ID}	mi/h	
Number of Lanes, N	2		f_N	mi/h	
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

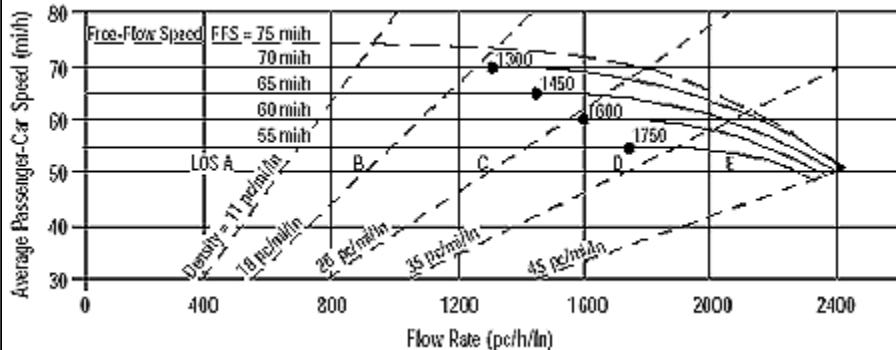
LOS and Performance Measures

Operational (LOS)			Design (N)	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	1451	pc/h/ln	Design (N)	
S	69.9	mi/h	Design LOS	
$D = v_p / S$	20.8	pc/mi/ln	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	pc/h
LOS	C		S	mi/h
			$D = v_p / S$	pc/mi/ln
			Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information

Analyst MJW
 Agency or Company URS CORPORATION
 Date Performed 01/23/2006
 Analysis Time Period AM PEAK

Project Description I-96/M-100 INTERCHANGE STUDY

Oper.(LOS)

Des.(N)

Planning Data

Flow Inputs

Volume, V	1405 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

Lane Width	12.0	ft	f_{LW}	mi/h	
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	mi/h	
Interchange Density	0.50	I/mi	f_{ID}	mi/h	
Number of Lanes, N	2		f_N	mi/h	
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

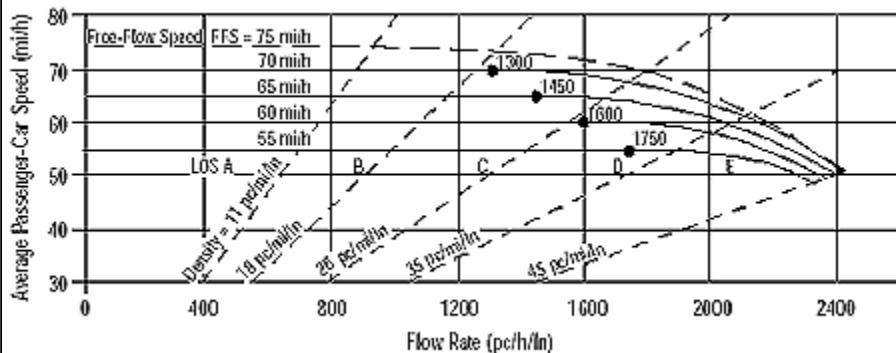
LOS and Performance Measures

Operational (LOS)	Design (N)
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	Design (N)
S	Design LOS
$D = v_p / S$	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$
LOS	S
B	$D = v_p / S$
	Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information

Analyst MJW
 Agency or Company URS CORPORATION
 Date Performed 01/23/2006
 Analysis Time Period AM PEAK

Project Description I-96/M-100 INTERCHANGE STUDY

Oper.(LOS)

Des.(N)

Planning Data

Flow Inputs

Volume, V	1365 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

Lane Width	12.0	ft	f_{LW}	mi/h	
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	mi/h	
Interchange Density	0.50	I/mi	f_{ID}	mi/h	
Number of Lanes, N	2		f_N	mi/h	
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

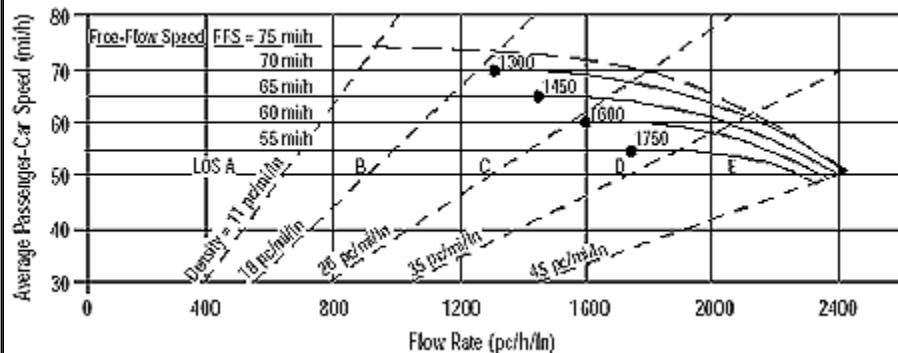
LOS and Performance Measures

Operational (LOS)	Design (N)
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	Design (N)
S	Design LOS
$D = v_p / S$	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$
LOS	S
B	$D = v_p / S$
	Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

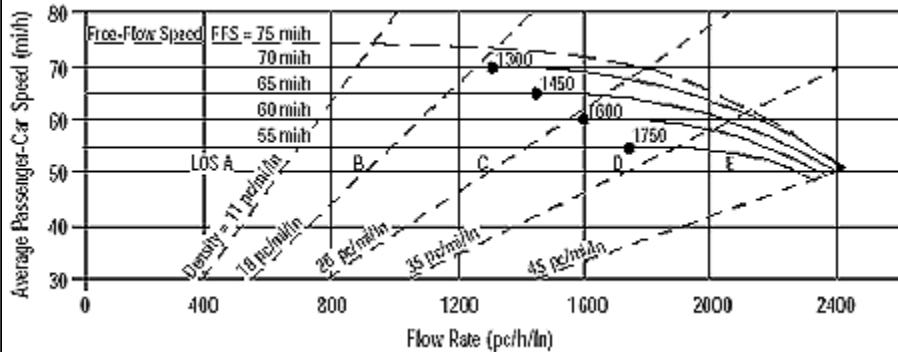
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	EB I-96
Agency or Company	URS CORPORATION	From/To	WEST OF M-100
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	PM PEAK	Analysis Year	2006
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		<input type="checkbox"/> Des.(N)	<input type="checkbox"/> Planning Data
Flow Inputs			
Volume, V	1560 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	f_{LW}	mi/h
Rt-Shoulder Lat. Clearance	6.0	f_{LC}	mi/h
Interchange Density	0.50	f_{ID}	mi/h
Number of Lanes, N	2	f_N	mi/h
FFS (measured)	70.0	FFS	70.0
Base free-flow Speed, BFFS	mi/h		mi/h
LOS and Performance Measures		Design (N)	
<u>Operational (LOS)</u>		<u>Design (N)</u>	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	914	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	pc/h/ln
S	70.0	S	mi/h
$D = v_p / S$	13.1	$D = v_p / S$	pc/mi/ln
LOS	B	Required Number of Lanes, N	
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

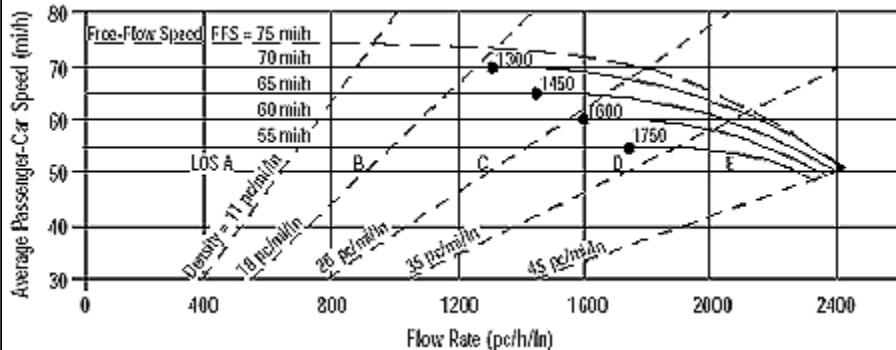
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	EB I-96
Agency or Company	URS CORPORATION	From/To	EAST OF M-100
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	PM PEAK	Analysis Year	2006
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		<input type="checkbox"/> Des.(N)	<input type="checkbox"/> Planning Data
Flow Inputs			
Volume, V	1680 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	f_{LW}	mi/h
Rt-Shoulder Lat. Clearance	6.0	f_{LC}	mi/h
Interchange Density	0.50	f_{ID}	mi/h
Number of Lanes, N	2	f_N	mi/h
FFS (measured)	70.0	FFS	70.0
Base free-flow Speed, BFFS	mi/h		mi/h
LOS and Performance Measures		Design (N)	
<u>Operational (LOS)</u>		<u>Design (N)</u>	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	985	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	pc/h
S	70.0	S	mi/h
$D = v_p / S$	14.1	$D = v_p / S$	pc/mi/ln
LOS	B	Required Number of Lanes, N	
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

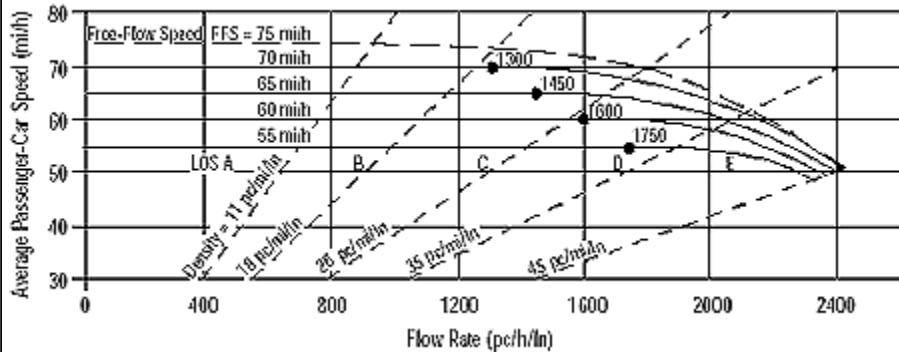
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	WB I-96
Agency or Company	URS CORPORATION	From/To	EAST OF M-100
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	PM PEAK	Analysis Year	2006
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		<input type="checkbox"/> Des.(N)	<input type="checkbox"/> Planning Data
Flow Inputs			
Volume, V	2515 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	ft	f_{LW} mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC} mi/h
Interchange Density	0.50	I/mi	f_{ID} mi/h
Number of Lanes, N	2		f_N mi/h
FFS (measured)	70.0	mi/h	FFS 70.0 mi/h
Base free-flow Speed, BFFS		mi/h	
LOS and Performance Measures		Design (N)	
<u>Operational (LOS)</u>		<u>Design (N)</u>	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	1474	pc/h/ln	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$ pc/h
S	69.9	mi/h	S mi/h
$D = v_p / S$	21.1	pc/mi/ln	$D = v_p / S$ pc/mi/ln
LOS	C		Required Number of Lanes, N
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	WB I-96
Agency or Company	URS CORPORATION	From/To	WEST OF M-100
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	PM PEAK	Analysis Year	2006
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		<input type="checkbox"/> Des.(N)	<input type="checkbox"/> Planning Data
Flow Inputs			
Volume, V	2260 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	ft	f_{LW} mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC} mi/h
Interchange Density	0.50	I/mi	f_{ID} mi/h
Number of Lanes, N	2		f_N mi/h
FFS (measured)	70.0	mi/h	FFS 70.0 mi/h
Base free-flow Speed, BFFS		mi/h	
LOS and Performance Measures		Design (N)	
<u>Operational (LOS)</u>		<u>Design (N)</u>	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	1325	pc/h/ln	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$ pc/h
S	70.0	mi/h	S mi/h
$D = v_p / S$	18.9	pc/mi/ln	$D = v_p / S$ pc/mi/ln
LOS	C		Required Number of Lanes, N
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

RAMPS AND RAMP JUNCTIONS WORKSHEET							
General Information		Site Information					
Analyst	MJW	Freeway/Dir of Travel			EB I-96		
Agency or Company	URS CORPORATION	Junction			M-100 OFF-RAMP		
Date Performed	01/23/2006	Jurisdiction			CLINTON COUNTY		
Analysis Time Period	AM PEAK	Analysis Year			2006		
Project Description I-96/M-100 INTERCHANGE STUDY							
Inputs							
Upstream Adj Ramp		Terrain: Level				Downstream Adj Ramp	
<input type="checkbox"/> Yes	<input type="checkbox"/> On					<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> On
<input checked="" type="checkbox"/> No	<input type="checkbox"/> Off					<input type="checkbox"/> No	<input type="checkbox"/> Off
L_{up} =	ft					L_{down} =	1625 ft
V_u =	veh/h	$S_{FF} = 70.0 \text{ mph}$				$S_{FR} = 35.0 \text{ mph}$	$V_D = 400 \text{ veh/h}$
Sketch (show lanes, L_A, L_D, V_R, V_f)							
Conversion to pc/h Under Base Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p
Freeway	2200	0.90	Level	11	0	0.948	1.00
Ramp	125	0.90	Level	16	0	0.926	1.00
UpStream							
DownStream	400	0.90	Level	7	0	0.966	1.00
Merge Areas				Diverge Areas			
Estimation of v_{12}				Estimation of v_{12}			
$V_{12} = V_F (P_{FM})$				$V_{12} = V_R + (V_F - V_R)P_{FD}$			
$L_{EQ} = \text{(Equation 25-2 or 25-3)}$				$L_{EQ} = \text{(Equation 25-8 or 25-9)}$			
$P_{FM} = \text{using Equation (Exhibit 25-5)}$				$P_{FD} = 1.000 \text{ using Equation (Exhibit 25-11)}$			
$V_{12} = \text{pc/h}$				$V_{12} = 2579 \text{ pc/h}$			
Capacity Checks				Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V_{FO}				$V_{FI} = V_F$	2579	4800	No
				V_{12}	2579	4400:All	No
V_{R12}				$V_{FO} = V_F - V_R$	2429	4800	No
				V_R	150	2000	No
Level of Service Determination (if not F)				Level of Service Determination (if not F)			
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$				$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$			
$D_R = \text{(pc/mi/ln)}$				$D_R = 21.9 \text{ (pc/mi/ln)}$			
LOS = (Exhibit 25-4)				LOS = C (Exhibit 25-4)			
Speed Estimation				Speed Estimation			
$M_S = \text{(Exhibit 25-19)}$				$D_S = 0.442 \text{ (Exhibit 25-19)}$			
$S_R = \text{mph (Exhibit 25-19)}$				$S_R = 57.6 \text{ mph (Exhibit 25-19)}$			
$S_0 = \text{mph (Exhibit 25-19)}$				$S_0 = \text{N/A mph (Exhibit 25-19)}$			
$S = \text{mph (Exhibit 25-14)}$				$S = 57.6 \text{ mph (Exhibit 25-15)}$			

RAMPS AND RAMP JUNCTIONS WORKSHEET							
General Information				Site Information			
Analyst	MJW	Freeway/Dir of Travel	EB I-96				
Agency or Company	URS CORPORATION	Junction	M-100 ON-RAMP				
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY				
Analysis Time Period	AM PEAK	Analysis Year	2006				
Project Description I-96/M-100 INTERCHANGE STUDY							
Inputs							
Upstream Adj Ramp	Terrain: Level				Downstream Adj Ramp		
	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> On	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> Yes	<input type="checkbox"/> On	
	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	L_{up}	1625 ft	<input type="checkbox"/> No	<input type="checkbox"/> Off	
	V_u	125 veh/h	S_{FF}	70.0 mph	S_{FR}	35.0 mph	V_d
Sketch (show lanes, L_A , L_D , V_R , V_f)							
Conversion to pc/h Under Base Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p
Freeway	2075	0.90	Level	11	0	0.948	1.00
Ramp	400	0.90	Level	7	0	0.966	1.00
UpStream	125	0.90	Level	16	0	0.926	1.00
DownStream							
Merge Areas				Diverge Areas			
Estimation of v_{12}				Estimation of v_{12}			
$v_{12} = V_F (P_{FM})$ $L_{EQ} =$ (Equation 25-2 or 25-3) $P_{FM} = 1.000$ using Equation (Exhibit 25-5) $V_{12} = 2432$ pc/h				$v_{12} = V_R + (V_F - V_R)P_{FD}$ $L_{EQ} =$ (Equation 25-8 or 25-9) $P_{FD} =$ using Equation (Exhibit 25-11) $V_{12} =$ pc/h			
Capacity Checks				Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V_{FO}	2892	See Exhibit 25-7	No	$V_{FI} = V_F$			
				V_{12}			
V_{R12}	2892	4600:All	No	$V_{FO} = V_F - V_R$			
				V_R			
Level of Service Determination (if not F)				Level of Service Determination (if not F)			
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$ $D_R = 24.7$ (pc/mi/ln) LOS = C (Exhibit 25-4)				$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$ $D_R =$ (pc/mi/ln) LOS = (Exhibit 25-4)			
Speed Estimation				Speed Estimation			
$M_S = 0.356$ (Exhibit 25-19) $S_R = 60.0$ mph (Exhibit 25-19) $S_0 = N/A$ mph (Exhibit 25-19) $S = 60.0$ mph (Exhibit 25-14)				$D_S =$ (Exhibit 25-19) $S_R =$ mph (Exhibit 25-19) $S_0 =$ mph (Exhibit 25-19) $S =$ mph (Exhibit 25-15)			

RAMPS AND RAMP JUNCTIONS WORKSHEET							
General Information		Site Information					
Analyst	MJW	Freeway/Dir of Travel			WB I-96		
Agency or Company	URS CORPORATION	Junction			M-100 OFF-RAMP		
Date Performed	01/23/2006	Jurisdiction			CLINTON COUNTY		
Analysis Time Period	AM PEAK	Analysis Year			2006		
Project Description I-96/M-100 INTERCHANGE STUDY							
Inputs							
Upstream Adj Ramp		Terrain: Level				Downstream Adj Ramp	
<input type="checkbox"/> Yes	<input type="checkbox"/> On					<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> On
<input checked="" type="checkbox"/> No	<input type="checkbox"/> Off					<input type="checkbox"/> No	<input type="checkbox"/> Off
L_{up} =	ft					L_{down} =	1625 ft
V_u =	veh/h	$S_{FF} = 70.0 \text{ mph}$				$S_{FR} = 35.0 \text{ mph}$	$V_D = 85 \text{ veh/h}$
Sketch (show lanes, L_A, L_D, V_R, V_f)							
Conversion to pc/h Under Base Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p
Freeway	1405	0.90	Level	11	0	0.948	1.00
Ramp	125	0.90	Level	10	0	0.952	1.00
UpStream							
DownStream	85	0.90	Level	8	0	0.962	1.00
Merge Areas				Diverge Areas			
Estimation of v_{12}				Estimation of v_{12}			
$V_{12} = V_F (P_{FM})$				$V_{12} = V_R + (V_F - V_R)P_{FD}$			
$L_{EQ} = \text{(Equation 25-2 or 25-3)}$				$L_{EQ} = \text{(Equation 25-8 or 25-9)}$			
$P_{FM} = \text{using Equation (Exhibit 25-5)}$				$P_{FD} = 1.000 \text{ using Equation (Exhibit 25-11)}$			
$V_{12} = \text{pc/h}$				$V_{12} = 1647 \text{ pc/h}$			
Capacity Checks				Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V_{FO}				$V_{FI} = V_F$	1647	4800	No
				V_{12}	1647	4400:All	No
V_{R12}				$V_{FO} = V_F - V_R$	1501	4800	No
				V_R	146	2000	No
Level of Service Determination (if not F)				Level of Service Determination (if not F)			
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$				$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$			
$D_R = \text{(pc/mi/ln)}$				$D_R = 13.9 \text{ (pc/mi/ln)}$			
LOS = (Exhibit 25-4)				LOS = B (Exhibit 25-4)			
Speed Estimation				Speed Estimation			
$M_S = \text{(Exhibit 25-19)}$				$D_S = 0.441 \text{ (Exhibit 25-19)}$			
$S_R = \text{mph (Exhibit 25-19)}$				$S_R = 57.6 \text{ mph (Exhibit 25-19)}$			
$S_0 = \text{mph (Exhibit 25-19)}$				$S_0 = \text{N/A mph (Exhibit 25-19)}$			
$S = \text{mph (Exhibit 25-14)}$				$S = 57.6 \text{ mph (Exhibit 25-15)}$			

RAMPS AND RAMP JUNCTIONS WORKSHEET							
General Information				Site Information			
Analyst	MJW	Freeway/Dir of Travel	WB I-96				
Agency or Company	URS CORPORATION	Junction	M-100 ON-RAMP				
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY				
Analysis Time Period	AM PEAK	Analysis Year	2006				
Project Description I-96/M-100 INTERCHANGE STUDY							
Inputs							
Upstream Adj Ramp	Terrain: Level				Downstream Adj Ramp		
	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> On	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> Yes	<input type="checkbox"/> On	
	L_{up} = 1625 ft	V_u = 125 veh/h	S_{FF} = 70.0 mph	S_{FR} = 35.0 mph	L_{down} = ft	V_d = veh/h	
Sketch (show lanes, L_A , L_D , V_R , V_f)							
Conversion to pc/h Under Base Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p
Freeway	1280	0.90	Level	11	0	0.948	1.00
Ramp	85	0.90	Level	8	0	0.962	1.00
UpStream	125	0.90	Level	10	0	0.952	1.00
DownStream							
Merge Areas				Diverge Areas			
Estimation of v_{12}				Estimation of v_{12}			
$V_{12} = V_F (P_{FM})$ $L_{EQ} =$ (Equation 25-2 or 25-3) $P_{FM} = 1.000$ using Equation (Exhibit 25-5) $V_{12} = 1500$ pc/h				$V_{12} = V_R + (V_F - V_R)P_{FD}$ $L_{EQ} =$ (Equation 25-8 or 25-9) $P_{FD} =$ using Equation (Exhibit 25-11) $V_{12} =$ pc/h			
Capacity Checks				Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V_{FO}	1598	See Exhibit 25-7	No	$V_{FI} = V_F$			
				V_{12}			
V_{R12}	1598	4600:All	No	$V_{FO} = V_F - V_R$			
				V_R			
Level of Service Determination (if not F)				Level of Service Determination (if not F)			
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$ $D_R = 14.8$ (pc/mi/ln) LOS = B (Exhibit 25-4)				$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$ $D_R =$ (pc/mi/ln) LOS = (Exhibit 25-4)			
Speed Estimation				Speed Estimation			
$M_S = 0.305$ (Exhibit 25-19) $S_R = 61.5$ mph (Exhibit 25-19) $S_0 = N/A$ mph (Exhibit 25-19) $S = 61.5$ mph (Exhibit 25-14)				$D_S =$ (Exhibit 25-19) $S_R =$ mph (Exhibit 25-19) $S_0 =$ mph (Exhibit 25-19) $S =$ mph (Exhibit 25-15)			

RAMPS AND RAMP JUNCTIONS WORKSHEET							
General Information				Site Information			
Analyst	MJW	Freeway/Dir of Travel	EB I-96				
Agency or Company	URS CORPORATION	Junction	M-100 OFF-RAMP				
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY				
Analysis Time Period	PM PEAK	Analysis Year	2006				
Project Description I-96/M-100 INTERCHANGE STUDY							
Inputs							
Upstream Adj Ramp	Terrain: Level				Downstream Adj Ramp		
	<input type="checkbox"/> Yes	<input type="checkbox"/> On	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> On			
	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Off	<input type="checkbox"/> No	<input type="checkbox"/> Off			
	L_{up} =	ft	L_{down} =	1625 ft			
V_u =	veh/h	S_{FF} = 70.0 mph	S_{FR} = 35.0 mph	V_D =	210 veh/h		
Sketch (show lanes, L_A , L_D , V_R , V_f)							
Conversion to pc/h Under Base Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p
Freeway	1560	0.90	Level	11	0	0.948	1.00
Ramp	90	0.90	Level	1	0	0.995	1.00
UpStream							
DownStream	210	0.90	Level	7	0	0.966	1.00
Merge Areas				Diverge Areas			
Estimation of v_{12}				Estimation of v_{12}			
$v_{12} = V_F (P_{FM})$				$v_{12} = V_R + (V_F - V_R)P_{FD}$			
$L_{EQ} =$ (Equation 25-2 or 25-3)				$L_{EQ} =$ (Equation 25-8 or 25-9)			
$P_{FM} =$ using Equation (Exhibit 25-5)				$P_{FD} =$ 1.000 using Equation (Exhibit 25-11)			
$V_{12} =$ pc/h				$V_{12} =$ 1829 pc/h			
Capacity Checks				Capacity Checks			
V_{FO}	Actual	Maximum	LOS F?	$V_{FI} = V_F$	Actual	Maximum	LOS F?
					V_{12}	1829	4400:All
V_{R12}				$V_{FO} = V_F - V_R$	1728	4800	No
				V_R	101	2000	No
Level of Service Determination (if not F)				Level of Service Determination (if not F)			
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$				$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$			
$D_R =$ (pc/mi/ln)				$D_R =$ 15.5 (pc/mi/ln)			
LOS = (Exhibit 25-4)				LOS = B (Exhibit 25-4)			
Speed Estimation				Speed Estimation			
$M_S =$ (Exhibit 25-19)				$D_s =$ 0.437 (Exhibit 25-19)			
$S_R =$ mph (Exhibit 25-19)				$S_R =$ 57.8 mph (Exhibit 25-19)			
$S_0 =$ mph (Exhibit 25-19)				$S_0 =$ N/A mph (Exhibit 25-19)			
$S =$ mph (Exhibit 25-14)				$S =$ 57.8 mph (Exhibit 25-15)			

RAMPS AND RAMP JUNCTIONS WORKSHEET							
General Information				Site Information			
Analyst	MJW	Freeway/Dir of Travel	EB I-96				
Agency or Company	URS CORPORATION	Junction	M-100 ON-RAMP				
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY				
Analysis Time Period	PM PEAK	Analysis Year	2006				
Project Description I-96/M-100 INTERCHANGE STUDY							
Inputs							
Upstream Adj Ramp	Terrain: Level				Downstream Adj Ramp		
	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> On	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> Yes	<input type="checkbox"/> On	
	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	L_{up}	1625 ft	<input type="checkbox"/> No	<input type="checkbox"/> Off	
	V_u	90 veh/h	S_{FF}	70.0 mph	S_{FR}	35.0 mph	V_d
Sketch (show lanes, L_A , L_D , V_R , V_f)							
Conversion to pc/h Under Base Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p
Freeway	1470	0.90	Level	11	0	0.948	1.00
Ramp	210	0.90	Level	7	0	0.966	1.00
UpStream	90	0.90	Level	1	0	0.995	1.00
DownStream							
Merge Areas				Diverge Areas			
Estimation of v_{12}				Estimation of v_{12}			
$v_{12} = V_F (P_{FM})$				$v_{12} = V_R + (V_F - V_R)P_{FD}$			
$L_{EQ} =$ (Equation 25-2 or 25-3)				$L_{EQ} =$ (Equation 25-8 or 25-9)			
$P_{FM} = 1.000$ using Equation (Exhibit 25-5)				$P_{FD} =$ using Equation (Exhibit 25-11)			
$v_{12} = 1723$ pc/h				$v_{12} =$ pc/h			
Capacity Checks				Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V_{FO}	1964	See Exhibit 25-7	No	$V_{FI} = V_F$			
				V_{12}			
V_{R12}	1964	4600:All	No	$V_{FO} = V_F - V_R$			
				V_R			
Level of Service Determination (if not F)				Level of Service Determination (if not F)			
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$				$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$			
$D_R = 17.5$ (pc/mi/ln)				$D_R =$ (pc/mi/ln)			
LOS = B (Exhibit 25-4)				LOS = (Exhibit 25-4)			
Speed Estimation				Speed Estimation			
$M_S = 0.314$ (Exhibit 25-19)				$D_S =$ (Exhibit 25-19)			
$S_R = 61.2$ mph (Exhibit 25-19)				$S_R =$ mph (Exhibit 25-19)			
$S_0 = N/A$ mph (Exhibit 25-19)				$S_0 =$ mph (Exhibit 25-19)			
$S = 61.2$ mph (Exhibit 25-14)				$S =$ mph (Exhibit 25-15)			

RAMPS AND RAMP JUNCTIONS WORKSHEET							
General Information				Site Information			
Analyst	MJW	Freeway/Dir of Travel	WB I-96				
Agency or Company	URS CORPORATION	Junction	M-100 OFF-RAMP				
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY				
Analysis Time Period	PM PEAK	Analysis Year	2006				
Project Description I-96/M-100 INTERCHANGE STUDY							
Inputs							
Upstream Adj Ramp	Terrain: Level				Downstream Adj Ramp		
					<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> On	<input checked="" type="checkbox"/> Yes
	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Off	<input type="checkbox"/> No	<input type="checkbox"/> Off			
L_{up} =	ft	L_{down} =	1625 ft				
V_u =	veh/h	$S_{FF} = 70.0 \text{ mph}$	$S_{FR} = 35.0 \text{ mph}$	$V_D = 105 \text{ veh/h}$			
Sketch (show lanes, L_A, L_D, V_R, V_f)							
Conversion to pc/h Under Base Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p
Freeway	2515	0.90	Level	11	0	0.948	1.00
Ramp	360	0.90	Level	2	0	0.990	1.00
UpStream							
DownStream	105	0.90	Level	3	0	0.985	1.00
Merge Areas				Diverge Areas			
Estimation of v_{12}				Estimation of v_{12}			
$v_{12} = V_F (P_{FM})$				$v_{12} = V_R + (V_F - V_R)P_{FD}$			
$L_{EQ} = \text{(Equation 25-2 or 25-3)}$				$L_{EQ} = \text{(Equation 25-8 or 25-9)}$			
$P_{FM} = \text{using Equation (Exhibit 25-5)}$				$P_{FD} = 1.000 \text{ using Equation (Exhibit 25-11)}$			
$V_{12} = \text{pc/h}$				$V_{12} = 2948 \text{ pc/h}$			
Capacity Checks				Capacity Checks			
V_{FO}	Actual	Maximum	LOS F?	$V_{FI} = V_F$	Actual	Maximum	LOS F?
					V_{12}	2948	4400:All
V_{R12}				$V_{FO} = V_F - V_R$	2544	4800	No
				V_R	404	2000	No
Level of Service Determination (if not F)				Level of Service Determination (if not F)			
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$				$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$			
$D_R = \text{(pc/mi/ln)}$				$D_R = 25.1 \text{ (pc/mi/ln)}$			
LOS = (Exhibit 25-4)				LOS = C (Exhibit 25-4)			
Speed Estimation				Speed Estimation			
$M_S = \text{(Exhibit 25-19)}$				$D_s = 0.464 \text{ (Exhibit 25-19)}$			
$S_R = \text{mph (Exhibit 25-19)}$				$S_R = 57.0 \text{ mph (Exhibit 25-19)}$			
$S_0 = \text{mph (Exhibit 25-19)}$				$S_0 = \text{N/A mph (Exhibit 25-19)}$			
$S = \text{mph (Exhibit 25-14)}$				$S = 57.0 \text{ mph (Exhibit 25-15)}$			

RAMPS AND RAMP JUNCTIONS WORKSHEET							
General Information				Site Information			
Analyst	MJW	Freeway/Dir of Travel	WB I-96				
Agency or Company	URS CORPORATION	Junction	M-100 ON-RAMP				
Date Performed	01/23/2006	Jurisdiction	CLINTON COUNTY				
Analysis Time Period	PM PEAK	Analysis Year	2006				
Project Description I-96/M-100 INTERCHANGE STUDY							
Inputs							
Upstream Adj Ramp	Terrain: Level				Downstream Adj Ramp		
	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> On	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> Yes	<input type="checkbox"/> On	
	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	L_{up} =	1625 ft	<input type="checkbox"/> No	<input type="checkbox"/> Off	
	V_u =	360 veh/h	S_{FF} =	70.0 mph	S_{FR} =	35.0 mph	L_{down} =
Sketch (show lanes, L_A , L_D , V_R , V_f)				V_d =	veh/h		
Conversion to pc/h Under Base Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p
Freeway	2155	0.90	Level	11	0	0.948	1.00
Ramp	105	0.90	Level	3	0	0.985	1.00
UpStream	360	0.90	Level	2	0	0.990	1.00
DownStream							
Merge Areas				Diverge Areas			
Estimation of v_{12}				Estimation of v_{12}			
$v_{12} = V_F (P_{FM})$				$v_{12} = V_R + (V_F - V_R)P_{FD}$			
$L_{EQ} =$ (Equation 25-2 or 25-3)				$L_{EQ} =$ (Equation 25-8 or 25-9)			
$P_{FM} = 1.000$ using Equation (Exhibit 25-5)				$P_{FD} =$ using Equation (Exhibit 25-11)			
$V_{12} = 2526$ pc/h				$V_{12} =$ pc/h			
Capacity Checks				Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V_{FO}	2644	See Exhibit 25-7	No	$V_{FI} = V_F$			
				V_{12}			
V_{R12}	2644	4600:All	No	$V_{FO} = V_F - V_R$			
				V_R			
Level of Service Determination (if not F)				Level of Service Determination (if not F)			
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$				$D_R = 4.252 + 0.0086 V_{12} - 0.0009 L_D$			
$D_R = 22.9$ (pc/mi/ln)				$D_R =$ (pc/mi/ln)			
LOS = C (Exhibit 25-4)				LOS = (Exhibit 25-4)			
Speed Estimation				Speed Estimation			
$M_S = 0.341$ (Exhibit 25-19)				$D_S =$ (Exhibit 25-19)			
$S_R = 60.5$ mph (Exhibit 25-19)				$S_R =$ mph (Exhibit 25-19)			
$S_0 = N/A$ mph (Exhibit 25-19)				$S_0 =$ mph (Exhibit 25-19)			
$S = 60.5$ mph (Exhibit 25-14)				$S =$ mph (Exhibit 25-15)			

Appendix B
No-Build Future (2030) Conditions
Capacity Analysis Worksheets

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

03/28/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0		4.0			4.0	
Lane Util. Factor				1.00		1.00		1.00			1.00	
Fr _t				1.00		0.85		1.00			0.99	
Flt Protected				0.95		1.00		0.97			1.00	
Satd. Flow (prot)				1597		1615		1698			1843	
Flt Permitted				0.95		1.00		0.45			1.00	
Satd. Flow (perm)				1597		1615		783			1843	
Volume (vph)	0	0	0	115	0	40	145	60	0	0	425	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.92	0.69	0.79	0.63	0.92	0.92	0.88	0.42
Adj. Flow (vph)	0	0	0	158	0	58	184	95	0	0	483	48
RTOR Reduction (vph)	0	0	0	0	0	49	0	0	0	0	5	0
Lane Group Flow (vph)	0	0	0	158	0	9	0	279	0	0	526	0
Heavy Vehicles (%)	2%	2%	2%	13%	0%	0%	10%	5%	0%	2%	2%	0%
Turn Type												
Protected Phases				6		6	3	3.8			4	
Permitted Phases							8					
Actuated Green, G (s)				9.2		9.2		44.4			34.2	
Effective Green, g (s)				11.0		11.0		47.0			36.0	
Actuated g/C Ratio				0.16		0.16		0.67			0.51	
Clearance Time (s)				5.8		5.8					5.8	
Lane Grp Cap (vph)				251		254		670			948	
v/s Ratio Prot				c0.10		0.01		c0.07			c0.29	
v/s Ratio Perm							0.21					
v/c Ratio				0.63		0.04		0.42			0.55	
Uniform Delay, d1				27.6		25.0		5.2			11.6	
Progression Factor				1.00		1.00		1.54			1.00	
Incremental Delay, d2				11.4		0.3		1.9			2.3	
Delay (s)				39.0		25.3		10.0			13.9	
Level of Service				D		C		A			B	
Approach Delay (s)	0.0				35.3			10.0			13.9	
Approach LOS	A				D			A			B	
Intersection Summary												
HCM Average Control Delay	17.3				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.54											
Actuated Cycle Length (s)	70.0				Sum of lost time (s)			12.0				
Intersection Capacity Utilization	51.1%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

2: EB I-96 off-ramp & M-100 (Wright Rd)

03/28/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0		4.0	
Lane Util. Factor	1.00			1.00				1.00	1.00		1.00	
Fr _t	1.00			0.85				1.00	0.85		1.00	
Flt Protected	0.95			1.00				1.00	1.00		0.97	
Satd. Flow (prot)	1805			1380				1712	1417		1774	
Flt Permitted	0.95			1.00				1.00	1.00		0.70	
Satd. Flow (perm)	1805			1380				1712	1417		1280	
Volume (vph)	20	0	155	0	0	0	0	200	200	265	275	0
Peak-hour factor, PHF	0.50	0.92	0.82	0.92	0.92	0.92	0.92	0.90	0.87	0.75	0.88	0.92
Adj. Flow (vph)	40	0	189	0	0	0	0	222	230	353	312	0
RTOR Reduction (vph)	0	0	159	0	0	0	0	0	112	0	0	0
Lane Group Flow (vph)	40	0	30	0	0	0	0	222	118	0	665	0
Heavy Vehicles (%)	0%	2%	17%	2%	2%	2%	2%	11%	14%	2%	7%	2%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	9.2		9.2					35.2	35.2		43.4	
Effective Green, g (s)	11.0		11.0					36.0	36.0		47.0	
Actuated g/C Ratio	0.16		0.16					0.51	0.51		0.67	
Clearance Time (s)	5.8		5.8					4.8	4.8			
Lane Grp Cap (vph)	284		217					880	729		937	
v/s Ratio Prot	c0.02		0.02					0.13			c0.11	
v/s Ratio Perm									0.08		c0.36	
v/c Ratio	0.14		0.14					0.25	0.16		0.71	
Uniform Delay, d1	25.4		25.4					9.5	9.0		7.2	
Progression Factor	1.00		1.00					1.00	1.00		1.80	
Incremental Delay, d2	1.0		1.3					0.7	0.5		3.8	
Delay (s)	26.5		26.7					10.2	9.5		16.8	
Level of Service	C		C					B	A		B	
Approach Delay (s)		26.7			0.0			9.8			16.8	
Approach LOS		C			A			A			B	
Intersection Summary												
HCM Average Control Delay	16.1				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.60											
Actuated Cycle Length (s)	70.0				Sum of lost time (s)			12.0				
Intersection Capacity Utilization	55.0%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

03/28/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control												
Volume (vph)												
Volume Total (vph)	20	120	60	145	35	95	30	235	170	130	305	10
Peak Hour Factor	0.70	0.98	0.58	0.73	0.79	0.79	0.63	0.77	0.77	0.73	0.78	0.25
Hourly flow rate (vph)	29	122	103	199	44	120	48	305	221	178	391	40
Direction, Lane #												
Volume Left (vph)	254	363	48	526	178	431						
Volume Right (vph)	29	199	48	0	178	0						
Hadj (s)	-0.10	0.10	0.58	-0.18	0.70	0.01						
Departure Headway (s)	9.0	8.7	9.3	8.6	9.4	8.7						
Degree Utilization, x	0.64	0.87	0.12	1.25	0.47	1.04						
Capacity (veh/h)	383	405	381	428	370	418						
Control Delay (s)	26.7	48.0	12.4	155.7	19.1	84.5						
Approach Delay (s)	26.7	48.0	143.8		65.4							
Approach LOS	D	E	F		F							
Intersection Summary												
Delay					81.4							
HCM Level of Service					F							
Intersection Capacity Utilization				70.0%		ICU Level of Service			C			
Analysis Period (min)				15								

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0		4.0			4.0	
Lane Util. Factor				1.00		1.00		1.00			1.00	
Fr _t				1.00		0.85		1.00			0.98	
Flt Protected				0.95		1.00		0.98			1.00	
Satd. Flow (prot)				1736		1615		1837			1765	
Flt Permitted				0.95		1.00		0.75			1.00	
Satd. Flow (perm)				1736		1615		1403			1765	
Volume (vph)	0	0	0	165	0	245	180	175	0	0	175	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.84	0.25	0.86	0.91	0.84	0.92	0.92	0.91	0.50
Adj. Flow (vph)	0	0	0	196	0	285	198	208	0	0	192	40
RTOR Reduction (vph)	0	0	0	0	0	240	0	0	0	0	11	0
Lane Group Flow (vph)	0	0	0	196	0	45	0	406	0	0	221	0
Heavy Vehicles (%)	2%	2%	2%	4%	2%	0%	2%	0%	0%	0%	1%	25%
Turn Type				Prot		custom	custom					
Protected Phases				6		6	3	3.8			4	
Permitted Phases							8					
Actuated Green, G (s)				9.2		9.2		44.4			34.2	
Effective Green, g (s)				11.0		11.0		47.0			36.0	
Actuated g/C Ratio				0.16		0.16		0.67			0.51	
Clearance Time (s)				5.8		5.8					5.8	
Lane Grp Cap (vph)				273		254		1010			908	
v/s Ratio Prot				c0.11		0.03		c0.06			0.13	
v/s Ratio Perm							c0.21					
v/c Ratio				0.72		0.18		0.40			0.24	
Uniform Delay, d1				28.0		25.6		5.2			9.4	
Progression Factor				1.00		1.00		0.55			1.00	
Incremental Delay, d2				15.0		1.5		1.1			0.6	
Delay (s)				43.0		27.1		4.0			10.1	
Level of Service				D		C		A			B	
Approach Delay (s)	0.0				33.6			4.0			10.1	
Approach LOS	A				C			A			B	
Intersection Summary												
HCM Average Control Delay	18.0				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.46											
Actuated Cycle Length (s)	70.0				Sum of lost time (s)			12.0				
Intersection Capacity Utilization	50.8%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

2: EB I-96 off-ramp & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0		4.0	
Lane Util. Factor	1.00			1.00				1.00	1.00		1.00	
Fr _t	1.00			0.85				1.00	0.85		1.00	
Flt Protected	0.95			1.00				1.00	1.00		0.98	
Satd. Flow (prot)	1805			1599				1863	1538		1753	
Flt Permitted	0.95			1.00				1.00	1.00		0.79	
Satd. Flow (perm)	1805			1599				1863	1538		1402	
Volume (vph)	25	0	140	0	0	0	0	340	160	100	240	0
Peak-hour factor, PHF	0.55	0.92	0.79	0.92	0.92	0.92	0.92	0.95	0.85	0.72	0.84	0.92
Adj. Flow (vph)	45	0	177	0	0	0	0	358	188	139	286	0
RTOR Reduction (vph)	0	0	149	0	0	0	0	0	91	0	0	0
Lane Group Flow (vph)	45	0	28	0	0	0	0	358	97	0	425	0
Heavy Vehicles (%)	0%	0%	1%	0%	0%	0%	0%	2%	5%	12%	4%	0%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	9.2		9.2					35.2	35.2		43.4	
Effective Green, g (s)	11.0		11.0					36.0	36.0		47.0	
Actuated g/C Ratio	0.16		0.16					0.51	0.51		0.67	
Clearance Time (s)	5.8		5.8					4.8	4.8			
Lane Grp Cap (vph)	284		251					958	791		997	
v/s Ratio Prot	c0.02		0.02					0.19			c0.07	
v/s Ratio Perm									0.06		c0.22	
v/c Ratio	0.16		0.11					0.37	0.12		0.43	
Uniform Delay, d1	25.5		25.3					10.2	8.8		5.3	
Progression Factor	1.00		1.00					1.00	1.00		2.32	
Incremental Delay, d2	1.2		0.9					1.1	0.3		1.1	
Delay (s)	26.7		26.2					11.3	9.1		13.4	
Level of Service	C		C					B	A		B	
Approach Delay (s)		26.3			0.0			10.6			13.4	
Approach LOS		C			A			B			B	
Intersection Summary												
HCM Average Control Delay		14.5		HCM Level of Service				B				
HCM Volume to Capacity ratio		0.38										
Actuated Cycle Length (s)		70.0		Sum of lost time (s)				12.0				
Intersection Capacity Utilization		49.4%		ICU Level of Service				A				
Analysis Period (min)		15										
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

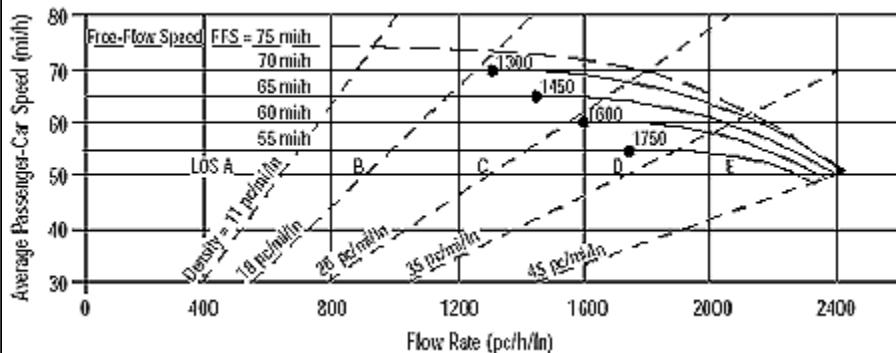
3: Grand River Ave & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	45	30	160	160	150	80	310	115	70	255	30
Peak Hour Factor	0.60	0.65	0.79	0.74	0.74	0.90	0.70	0.81	0.84	0.74	0.92	0.64
Hourly flow rate (vph)	33	69	38	216	216	167	114	383	137	95	277	47
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total (vph)	141	599	114	520	95	324						
Volume Left (vph)	33	216	114	0	95	0						
Volume Right (vph)	38	167	0	137	0	47						
Hadj (s)	0.03	-0.05	0.50	-0.17	0.64	-0.07						
Departure Headway (s)	8.9	7.4	8.5	7.8	9.0	8.2						
Degree Utilization, x	0.35	1.23	0.27	1.13	0.24	0.74						
Capacity (veh/h)	389	478	419	464	396	428						
Control Delay (s)	16.7	145.1	13.4	107.8	13.5	30.3						
Approach Delay (s)	16.7	145.1	90.8		26.5							
Approach LOS	C	F	F		D							
Intersection Summary												
Delay					88.1							
HCM Level of Service					F							
Intersection Capacity Utilization				70.3%			ICU Level of Service			C		
Analysis Period (min)				15								

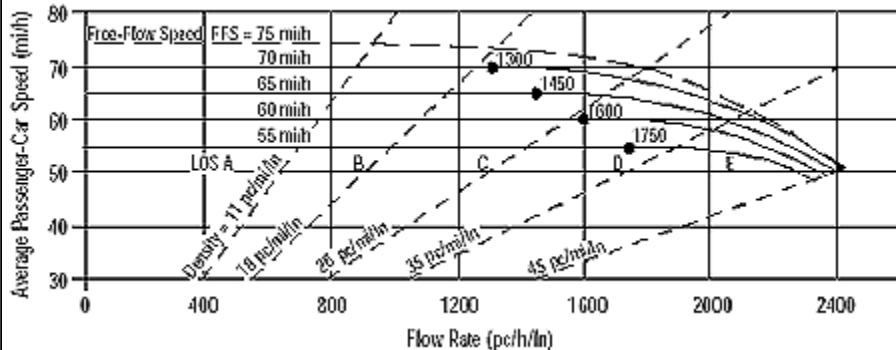
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	EB I-96
Agency or Company	URS CORPORATION	From/To	WEST OF M-100
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	AM PEAK	Analysis Year	2030 NO-BUILD
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		<input type="checkbox"/> Des.(N)	<input type="checkbox"/> Planning Data
Flow Inputs			
Volume, V	3625 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	ft	f_{LW} mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC} mi/h
Interchange Density	0.50	I/mi	f_{ID} mi/h
Number of Lanes, N	2		f_N mi/h
FFS (measured)	70.0	mi/h	FFS 70.0 mi/h
Base free-flow Speed, BFFS		mi/h	
LOS and Performance Measures		Design (N)	
<u>Operational (LOS)</u>		<u>Design (N)</u>	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	2125	pc/h/ln	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$ pc/h
S	62.1	mi/h	S mi/h
$D = v_p / S$	34.2	pc/mi/ln	$D = v_p / S$ pc/mi/ln
LOS	D		Required Number of Lanes, N
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information

Analyst MJW
 Agency or Company URS CORPORATION
 Date Performed 02/01/2006
 Analysis Time Period AM PEAK

Project Description I-96/M-100 INTERCHANGE STUDY

Oper.(LOS)

Des.(N)

Planning Data

Flow Inputs

Volume, V	3915 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

Lane Width	12.0	ft	f_{LW}	mi/h	
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	mi/h	
Interchange Density	0.50	I/mi	f_{ID}	mi/h	
Number of Lanes, N	2		f_N	mi/h	
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

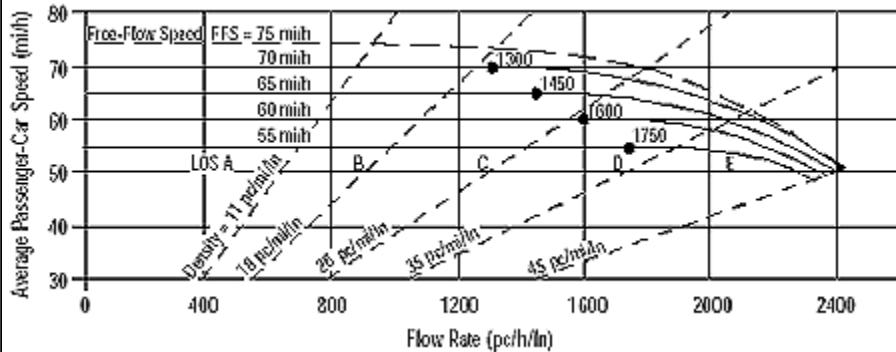
LOS and Performance Measures

Operational (LOS)	Design (N)
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	Design (N)
S	Design LOS
$D = v_p / S$	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$
LOS	S
E	$D = v_p / S$
	Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

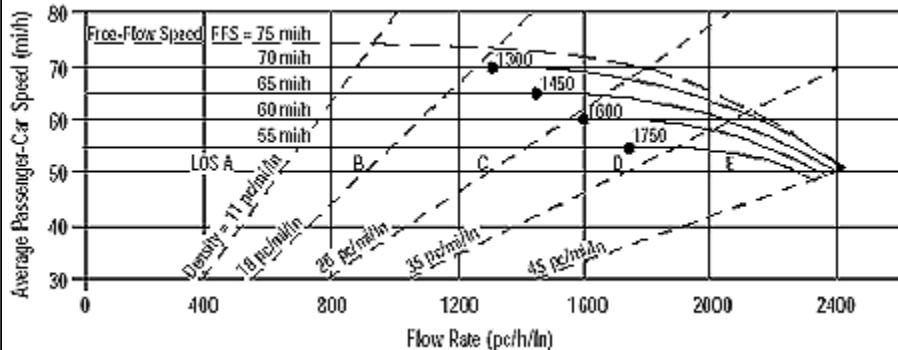
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	WB I-96
Agency or Company	URS CORPORATION	From/To	EAST OF M-100
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	AM PEAK	Analysis Year	2030 NO-BUILD
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		<input type="checkbox"/> Des.(N)	<input type="checkbox"/> Planning Data
Flow Inputs			
Volume, V	2285 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	ft	f_{LW} mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC} mi/h
Interchange Density	0.50	I/mi	f_{ID} mi/h
Number of Lanes, N	2		f_N mi/h
FFS (measured)	70.0	mi/h	FFS 70.0 mi/h
Base free-flow Speed, BFFS		mi/h	
LOS and Performance Measures		Design (N)	
<u>Operational (LOS)</u>		<u>Design (N)</u>	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	1339	pc/h/ln	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$ pc/h
S	70.0	mi/h	S mi/h
$D = v_p / S$	19.1	pc/mi/ln	$D = v_p / S$ pc/mi/ln
LOS	C		Required Number of Lanes, N
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

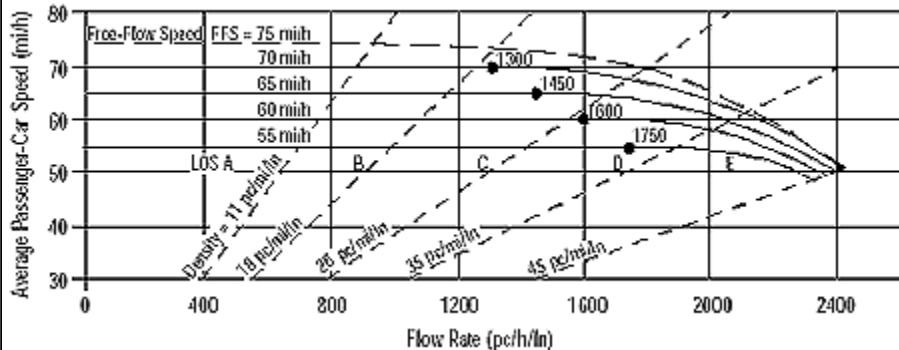
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	WB I-96
Agency or Company	URS CORPORATION	From/To	WEST OF M-100
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	AM PEAK	Analysis Year	2030 NO-BUILD
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		<input type="checkbox"/> Des.(N)	<input type="checkbox"/> Planning Data
Flow Inputs			
Volume, V	2295 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	ft	f_{LW} mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC} mi/h
Interchange Density	0.50	I/mi	f_{ID} mi/h
Number of Lanes, N	2		f_N mi/h
FFS (measured)	70.0	mi/h	FFS 70.0 mi/h
Base free-flow Speed, BFFS		mi/h	
LOS and Performance Measures		Design (N)	
<u>Operational (LOS)</u>		<u>Design (N)</u>	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	1345	pc/h/ln	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$ pc/h
S	70.0	mi/h	S mi/h
$D = v_p / S$	19.2	pc/mi/ln	$D = v_p / S$ pc/mi/ln
LOS	C		Required Number of Lanes, N
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

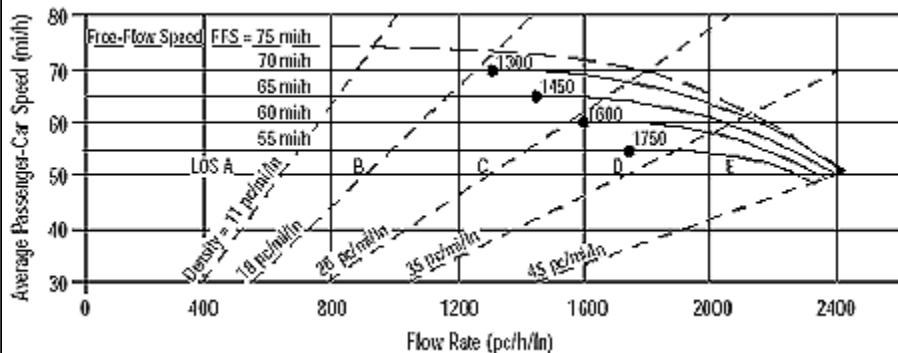
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	EB I-96
Agency or Company	URS CORPORATION	From/To	WEST OF M-100
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	PM PEAK	Analysis Year	2030 NO-BUILD
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		Des.(N)	Planning Data
Flow Inputs			
Volume, V	2570 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	ft	f_{LW} mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC} mi/h
Interchange Density	0.50	I/mi	f_{ID} mi/h
Number of Lanes, N	2		f_N mi/h
FFS (measured)	70.0	mi/h	FFS 70.0 mi/h
Base free-flow Speed, BFFS		mi/h	
LOS and Performance Measures		Design (N)	
Operational (LOS)		Design (N)	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	1506	pc/h/ln	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$ pc/h
S	69.8	mi/h	S mi/h
$D = v_p / S$	21.6	pc/mi/ln	$D = v_p / S$ pc/mi/ln
LOS	C		Required Number of Lanes, N
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

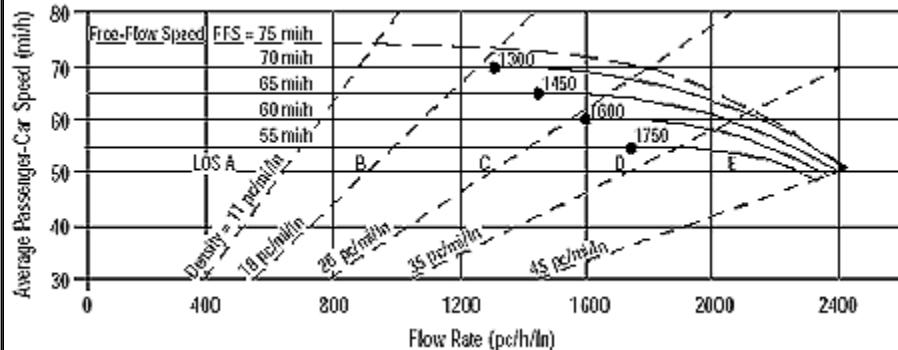
BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	EB I-96
Agency or Company	URS CORPORATION	From/To	EAST OF M-100
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	PM PEAK	Analysis Year	2030 NO-BUILD
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		<input type="checkbox"/> Des.(N)	<input type="checkbox"/> Planning Data
Flow Inputs			
Volume, V	2665 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	f_{LW}	mi/h
Rt-Shoulder Lat. Clearance	6.0	f_{LC}	mi/h
Interchange Density	0.50	f_{ID}	mi/h
Number of Lanes, N	2	f_N	mi/h
FFS (measured)	70.0	FFS	70.0
Base free-flow Speed, BFFS	mi/h		mi/h
LOS and Performance Measures		Design (N)	
<u>Operational (LOS)</u>		<u>Design (N)</u>	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	1562	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	pc/h
S	69.6	S	mi/h
$D = v_p / S$	22.4	$D = v_p / S$	pc/mi/ln
LOS	C	Required Number of Lanes, N	
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information

Analyst MJW
 Agency or Company URS CORPORATION
 Date Performed 02/01/2006
 Analysis Time Period PM PEAK

Project Description I-96/M-100 INTERCHANGE STUDY

Oper.(LOS)

Des.(N)

Planning Data

Flow Inputs

Volume, V	4010 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

Lane Width	12.0	ft	f_{LW}	mi/h	
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC}	mi/h	
Interchange Density	0.50	I/mi	f_{ID}	mi/h	
Number of Lanes, N	2		f_N	mi/h	
FFS (measured)	70.0	mi/h	FFS	70.0	mi/h
Base free-flow Speed, BFFS		mi/h			

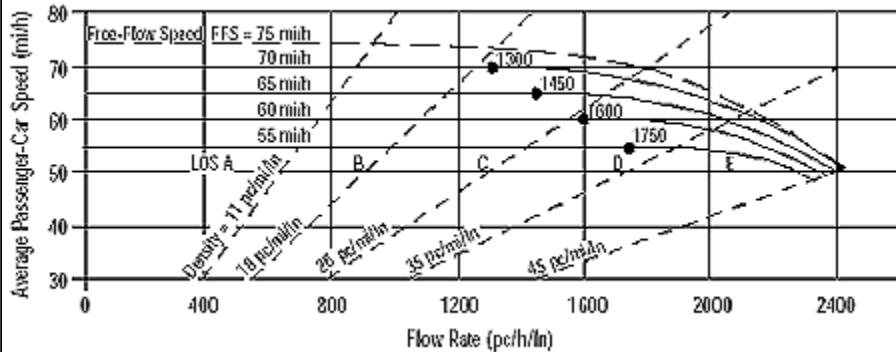
LOS and Performance Measures

Operational (LOS)	Design (N)
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	Design (N)
S	Design LOS
$D = v_p / S$	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$
LOS	S
E	$D = v_p / S$
	Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p , S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p , S, D

General Information		Site Information	
Analyst	MJW	Highway/Direction of Travel	WB I-96
Agency or Company	URS CORPORATION	From/To	WEST OF M-100
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY
Analysis Time Period	PM PEAK	Analysis Year	2030 NO-BUILD
Project Description I-96/M-100 INTERCHANGE STUDY			
<input checked="" type="checkbox"/> Oper.(LOS)		<input type="checkbox"/> Des.(N)	<input type="checkbox"/> Planning Data
Flow Inputs			
Volume, V	3800 veh/h	Peak-Hour Factor, PHF	0.90
AADT	veh/day	%Trucks and Buses, P_T	11
Peak-Hr Prop. of AADT, K		%RVs, P_R	0
Peak-Hr Direction Prop, D		General Terrain:	Level
DDHV = AADT x K x D	veh/h	Grade % Length	mi
Driver type adjustment	1.00	Up/Down %	
Calculate Flow Adjustments			
f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948
Speed Inputs		Calc Speed Adj and FFS	
Lane Width	12.0	ft	f_{LW} mi/h
Rt-Shoulder Lat. Clearance	6.0	ft	f_{LC} mi/h
Interchange Density	0.50	I/mi	f_{ID} mi/h
Number of Lanes, N	2		f_N mi/h
FFS (measured)	70.0	mi/h	FFS 70.0 mi/h
Base free-flow Speed, BFFS		mi/h	
LOS and Performance Measures		Design (N)	
<u>Operational (LOS)</u>		<u>Design (N)</u>	
$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$	2227	pc/h/ln	$v_p = (V \text{ or } DDHV) / (\text{PHF} \times N \times f_{HV} \times f_p)$ pc/h
S	59.3	mi/h	S mi/h
$D = v_p / S$	37.5	pc/mi/ln	$D = v_p / S$ pc/mi/ln
LOS	E		Required Number of Lanes, N
Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 23-8, 23-10	f_{LW} - Exhibit 23-4
V - Hourly volume	D - Density	E_T - Exhibits 23-8, 23-10, 23-11	f_{LC} - Exhibit 23-5
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 23-12	f_N - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 23-2, 23-3	f_{ID} - Exhibit 23-7
DDHV - Directional design hour volume			

RAMPS AND RAMP JUNCTIONS WORKSHEET								
General Information				Site Information				
Analyst	MJW	Freeway/Dir of Travel	EB I-96					
Agency or Company	URS CORPORATION	Junction	M-100 OFF-RAMP					
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY					
Analysis Time Period	AM PEAK	Analysis Year	2030 NO-BUILD					
Project Description I-96/M-100 INTERCHANGE STUDY								
Inputs								
Upstream Adj Ramp	Terrain Level						Downstream Adj Ramp	
<input type="checkbox"/> Yes <input type="checkbox"/> On						<input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On		
<input checked="" type="checkbox"/> No <input type="checkbox"/> Off						<input type="checkbox"/> No <input type="checkbox"/> Off		
L_{up} = ft	$S_{FF} = 70.0 \text{ mph}$ $S_{FR} = 35.0 \text{ mph}$					$L_{down} = 1625 \text{ ft}$		
V_u = veh/h	Sketch (show lanes, L_A , L_D , V_R , V_f)					$VD = 465 \text{ veh/h}$		
Conversion to pc/h Under Base Conditions								
(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF f_{HV}$ f_p
Freeway	3625	0.90	Level	11	0	0.948	1.00	4249
Ramp	175	0.90	Level	16	0	0.926	1.00	210
UpStream								
DownStream	465	0.90	Level	7	0	0.966	1.00	535
Merge Areas					Diverge Areas			
Estimation of v_{12}					Estimation of v_{12}			
$V_{12} = V_F (P_{FM})$ $L_{EQ} = (\text{Equation 25-2 or 25-3})$ $P_{FM} = \text{using Equation}$ $V_{12} = \text{pc/h}$					$V_{12} = V_R + (V_F - V_R)P_{FD}$ $L_{EQ} = (\text{Equation 25-8 or 25-9})$ $P_{FD} = 1.000 \text{ using Equation 0}$ $V_{12} = 4249 \text{ pc/h}$			
Capacity Checks					Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?	
V_{FO}	See Exhibit 25-7			$V_{FI}=V_F$	4249	4800	No	
				V_{12}	4249	4400:All	No	
V_{R12}	4600:All			$V_{FO} = V_F - V_R$	4039	4800	No	
				V_R	210	2000	No	
Level of Service Determination (if not F)				Level of Service Determination (if not F)				
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$ $D_R = \text{(pc/ mi /ln)}$ $LOS = \text{(Exhibit 25-4)}$				$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$ $D_R = 36.3 \text{ (pc/ mi /ln)}$ $LOS = E \text{ (Exhibit 25-4)}$				
Speed Estimation				Speed Estimation				
$M_S = \text{(Exhibit 25-19)}$ $S_R = \text{mph (Exhibit 25-19)}$ $S_0 = \text{mph (Exhibit 25-19)}$ $S = \text{mph (Exhibit 25-14)}$				$D_S = 0.447 \text{ (Exhibit 25-19)}$ $S_R = 57.5 \text{ mph (Exhibit 25-19)}$ $S_0 = \text{N/A mph (Exhibit 25-19)}$ $S = 57.5 \text{ mph (Exhibit 25-15)}$				

RAMPS AND RAMP JUNCTIONS WORKSHEET							
General Information				Site Information			
Analyst2	MJW	Freeway/Dir of Travel	EB I-96				
Agency or Company	URS CORPORATION	Junction	M-100 ON-RAMP				
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY				
Analysis Time Period	AM PEAK	Analysis Year	2030 NO-BUILD				
Project Description I-96/M-100 INTERCHANGE STUDY							
Inputs							
Upstream Adj Ramp	Terrain Level				Downstream Adj Ramp		
	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> On	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> Yes	<input type="checkbox"/> On	
	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	L_{up} =	1625 ft	L_{down} =	ft	
V_u =	175 veh/h	S_{FF} =	70.0 mph	S_{FR} =	35.0 mph	VD =	veh/h
Sketch (show lanes, L_A , L_D , V_R , V_f)							
Conversion to pc/h Under Base Conditions							
(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p
Freeway	3450	0.90	Level	11	0	0.948	1.00
Ramp	465	0.90	Level	7	0	0.966	1.00
UpStream	175	0.90	Level	16	0	0.926	1.00
DownStream							
Merge Areas				Diverge Areas			
Estimation of v_{12}				Estimation of v_{12}			
$v_{12} = V_F (P_{FM})$				$v_{12} = V_R + (V_F - V_R)P_{FD}$			
$L_{EQ} =$ (Equation 25-2 or 25-3)				$L_{EQ} =$ (Equation 25-8 or 25-9)			
$P_{FM} =$ 1.000 using Equation 0				$P_{FD} =$ using Equation			
$V_{12} =$ 4044 pc/h				$V_{12} =$ pc/h			
Capacity Checks				Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V_{FO}	4579	See Exhibit 25-7	No	$V_{FI}=V_F$		See Exhibit 25-14	
				V_{12}		4400:All	
V_{R12}	4579	4600:All	No	$V_{FO} = V_F - V_R$		See Exhibit 25-14	
				V_R		See Exhibit 25-3	
Level of Service Determination (if not F)				Level of Service Determination (if not F)			
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$				$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$			
$D_R =$ 37.8 (pc/m/in)				$D_R =$ (pc/m/in)			
LOS = E (Exhibit 25-4)				LOS = (Exhibit 25-4)			
Speed Estimation				Speed Estimation			
$M_S =$ 0.666 (Exhibit 25-19)				$D_s =$ (Exhibit 25-19)			
$S_R =$ 51.4 mph (Exhibit 25-19)				$S_R =$ mph (Exhibit 25-19)			
$S_0 =$ N/A mph (Exhibit 25-19)				$S_0 =$ mph (Exhibit 25-19)			
$S =$ 51.4 mph (Exhibit 25-14)				$S =$ mph (Exhibit 25-15)			

RAMPS AND RAMP JUNCTIONS WORKSHEET								
General Information				Site Information				
Analyst	MJW	Freeway/Dir of Travel			WB I-96			
Agency or Company	URS CORPORATION	Junction			M-100 OFF-RAMP			
Date Performed	02/01/2006	Jurisdiction			CLINTON COUNTY			
Analysis Time Period	AM PEAK	Analysis Year			2030 NO-BUILD			
Project Description I-96/M-100 INTERCHANGE STUDY								
Inputs								
Upstream Adj Ramp	Terrain Level					Downstream Adj Ramp		
	<input type="checkbox"/> Yes	<input type="checkbox"/> On	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> On				
	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Off	<input type="checkbox"/> No	<input type="checkbox"/> Off				
L_{up} =	ft	L_{down} =	1625 ft					
Vu =	veh/h	S_{FF} =	70.0 mph	S_{FR} =	35.0 mph	VD =	165 veh/h	
Sketch (show lanes, L_A , L_D , V_R , V_f)								
Conversion to pc/h Under Base Conditions								
(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF f_{HV}$ f_p
Freeway	2285	0.90	Level	11	0	0.948	1.00	2679
Ramp	155	0.90	Level	10	0	0.952	1.00	181
UpStream								
DownStream	165	0.90	Level	8	0	0.962	1.00	191
Merge Areas					Diverge Areas			
Estimation of v_{12}					Estimation of v_{12}			
$V_{12} = V_F (P_{FM})$					$V_{12} = V_R + (V_F - V_R)P_{FD}$			
$L_{EQ} =$ (Equation 25-2 or 25-3)					$L_{EQ} =$ (Equation 25-8 or 25-9)			
P_{FM} = using Equation					$P_{FD} = 1.000$ using Equation 0			
$V_{12} =$ pc/h					$V_{12} = 2679$ pc/h			
Capacity Checks					Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?	
V_{FO}		See Exhibit 25-7		$V_{FI}=V_F$	2679	4800	No	
				V_{12}	2679	4400:All	No	
V_{R12}		4600:All		$V_{FO} = V_F - V_R$	2498	4800	No	
				V_R	181	2000	No	
Level of Service Determination (if not F)				Level of Service Determination (if not F)				
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$				$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$				
$D_R =$ (pc/ mi /ln)				$D_R =$ 22.8 (pc/ mi /ln)				
LOS = (Exhibit 25-4)				LOS= C (Exhibit 25-4)				
Speed Estimation				Speed Estimation				
$M_S =$ (Exhibit 25-19)				$D_S =$ 0.444 (Exhibit 25-19)				
$S_R =$ mph (Exhibit 25-19)				$S_R =$ 57.6 mph (Exhibit 25-19)				
$S_0 =$ mph (Exhibit 25-19)				$S_0 =$ N/A mph (Exhibit 25-19)				
$S =$ mph (Exhibit 25-14)				$S =$ 57.6 mph (Exhibit 25-15)				

RAMPS AND RAMP JUNCTIONS WORKSHEET								
General Information				Site Information				
Analyst2	MJW	Freeway/Dir of Travel	WB I-96					
Agency or Company	URS CORPORATION	Junction	M-100 ON-RAMP					
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY					
Analysis Time Period	AM PEAK	Analysis Year	2030 NO-BUILD					
Project Description I-96/M-100 INTERCHANGE STUDY								
Inputs								
Upstream Adj Ramp	Terrain Level					Downstream Adj Ramp		
	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> On	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> Yes	<input type="checkbox"/> On		
	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> L _{up} =	1625 ft	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Off		
	V _u =	155 veh/h	S _{FF} =	70.0 mph	S _{FR} =	35.0 mph	L _{down} =	ft
Sketch (show lanes, L _A , L _D , V _R , V _f)					V _D =	veh/h		
Conversion to pc/h Under Base Conditions								
(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f _{HV}	f _p	v=V/PHF f _{HV} f _p
Freeway	2130	0.90	Level	11	0	0.948	1.00	2497
Ramp	165	0.90	Level	8	0	0.962	1.00	191
UpStream	155	0.90	Level	10	0	0.952	1.00	181
DownStream								
Merge Areas					Diverge Areas			
Estimation of v ₁₂					Estimation of v ₁₂			
V ₁₂ = V _F (P _{FM}) L _{EQ} = (Equation 25-2 or 25-3) P _{FM} = 1.000 using Equation 0 V ₁₂ = 2497 pc/h					V ₁₂ = V _R + (V _F - V _R)P _{FD} L _{EQ} = (Equation 25-8 or 25-9) P _{FD} = using Equation V ₁₂ = pc/h			
Capacity Checks					Capacity Checks			
	Actual	Maximum	LOS F?			Actual	Maximum	LOS F?
V _{FO}	2688	See Exhibit 25-7	No	V _{FI} =V _F		See Exhibit 25-14		
				V ₁₂		4400:All		
V _{R12}	2688	4600:All	No	V _{FO} = V _F - V _R		See Exhibit 25-14		
				V _R		See Exhibit 25-3		
Level of Service Determination (if not F)					Level of Service Determination (if not F)			
D _R = 5.475 + 0.00734 V _R + 0.0078 V ₁₂ - 0.00627 L _A D _R = 23.2 (pc/ m/in) LOS = C (Exhibit 25-4)					D _R = 4.252 + 0.0086 V ₁₂ - 0.009 L _D D _R = (pc/ m/in) LOS = (Exhibit 25-4)			
Speed Estimation					Speed Estimation			
M _S = 0.343 (Exhibit 25-19) S _R = 60.4 mph (Exhibit 25-19) S ₀ = N/A mph (Exhibit 25-19) S = 60.4 mph (Exhibit 25-14)					D _s = (Exhibit 25-19) S _R = mph (Exhibit 25-19) S ₀ = mph (Exhibit 25-19) S = mph (Exhibit 25-15)			

RAMPS AND RAMP JUNCTIONS WORKSHEET								
General Information				Site Information				
Analyst	MJW			Freeway/Dir of Travel	EB I-96			
Agency or Company	URS CORPORATION			Junction	M-100 OFF-RAMP			
Date Performed	02/01/2006			Jurisdiction	CLINTON COUNTY			
Analysis Time Period	PM PEAK			Analysis Year	2030 NO-BUILD			
Project Description I-96/M-100 INTERCHANGE STUDY								
Inputs								
Upstream Adj Ramp	Terrain Level					Downstream Adj Ramp		
	<input type="checkbox"/> Yes	<input type="checkbox"/> On	<input checked="" type="checkbox"/> Yes	<input checked="" type="checkbox"/> On				
	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Off	<input type="checkbox"/> No	<input type="checkbox"/> Off				
L_{up} =	ft	L_{down} =	1625 ft					
Vu =	veh/h	S_{FF} = 70.0 mph	S_{FR} = 35.0 mph	VD =	260 veh/h			
Sketch (show lanes, L_A , L_D , V_R , V_f)								
Conversion to pc/h Under Base Conditions								
(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f_{HV}	f_p	$v=V/PHF f_{HV}$ f_p
Freeway	2570	0.90	Level	11	0	0.948	1.00	3013
Ramp	165	0.90	Level	1	0	0.995	1.00	184
UpStream								
DownStream	260	0.90	Level	7	0	0.966	1.00	299
Merge Areas					Diverge Areas			
Estimation of v_{12}					Estimation of v_{12}			
$V_{12} = V_F (P_{FM})$ $L_{EQ} =$ (Equation 25-2 or 25-3) P_{FM} = using Equation V_{12} = pc/h					$V_{12} = V_R + (V_F - V_R)P_{FD}$ $L_{EQ} =$ (Equation 25-8 or 25-9) $P_{FD} = 1.000$ using Equation 0 $V_{12} = 3013$ pc/h			
Capacity Checks					Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?	
V_{FO}		See Exhibit 25-7		$V_{FI}=V_F$	3013	4800	No	
				V_{12}	3013	4400:All	No	
V_{R12}		4600:All		$V_{FO} = V_F - V_R$	2829	4800	No	
				V_R	184	2000	No	
Level of Service Determination (if not F)				Level of Service Determination (if not F)				
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$ D_R = (pc/ mi /ln) LOS = (Exhibit 25-4)				$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$ D_R = 25.7 (pc/ mi /ln) LOS= C (Exhibit 25-4)				
Speed Estimation				Speed Estimation				
M_S = (Exhibit 25-19) S_R = mph (Exhibit 25-19) S_0 = mph (Exhibit 25-19) S = mph (Exhibit 25-14)				D_S = 0.445 (Exhibit 25-19) S_R = 57.6 mph (Exhibit 25-19) S_0 = N/A mph (Exhibit 25-19) S = 57.6 mph (Exhibit 25-15)				

RAMPS AND RAMP JUNCTIONS WORKSHEET								
General Information				Site Information				
Analyst2	MJW	Freeway/Dir of Travel	EB I-96					
Agency or Company	URS CORPORATION	Junction	M-100 ON-RAMP					
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY					
Analysis Time Period	PM PEAK	Analysis Year	2030 NO-BUILD					
Project Description I-96/M-100 INTERCHANGE STUDY								
Inputs								
Upstream Adj Ramp	Terrain Level					Downstream Adj Ramp		
	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> On	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> Yes	<input type="checkbox"/> On	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Off
	L _{up} =	1625 ft				L _{down} =	ft	
V _u =	165 veh/h	S _{FF} = 70.0 mph S _{FR} = 35.0 mph			V _D =	veh/h		
Sketch (show lanes, L _A , L _D , V _R , V _f)								
Conversion to pc/h Under Base Conditions								
(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f _{HV}	f _p	v=V/PHF f _{HV} f _p
Freeway	2405	0.90	Level	11	0	0.948	1.00	2819
Ramp	260	0.90	Level	7	0	0.966	1.00	299
UpStream	165	0.90	Level	1	0	0.995	1.00	184
DownStream								
Merge Areas					Diverge Areas			
Estimation of v ₁₂					Estimation of v ₁₂			
V ₁₂ = V _F (P _{FM}) L _{EQ} = (Equation 25-2 or 25-3) P _{FM} = 1.000 using Equation 0 V ₁₂ = 2819 pc/h					V ₁₂ = V _R + (V _F - V _R)P _{FD} L _{EQ} = (Equation 25-8 or 25-9) P _{FD} = using Equation V ₁₂ = pc/h			
Capacity Checks					Capacity Checks			
	Actual	Maximum	LOS F?			Actual	Maximum	LOS F?
V _{FO}	3118	See Exhibit 25-7	No	V _{FI} =V _F		See Exhibit 25-14		
				V ₁₂		4400:All		
V _{R12}	3118	4600:All	No	V _{FO} = V _F - V _R		See Exhibit 25-14		
				V _R		See Exhibit 25-3		
Level of Service Determination (if not F)					Level of Service Determination (if not F)			
D _R = 5.475 + 0.00734 V _R + 0.0078 V ₁₂ - 0.00627 L _A D _R = 26.5 (pc/ m/in) LOS = C (Exhibit 25-4)					D _R = 4.252 + 0.0086 V ₁₂ - 0.009 L _D D _R = (pc/ m/in) LOS = (Exhibit 25-4)			
Speed Estimation					Speed Estimation			
M _S = 0.374 (Exhibit 25-19) S _R = 59.5 mph (Exhibit 25-19) S ₀ = N/A mph (Exhibit 25-19) S = 59.5 mph (Exhibit 25-14)					D _s = (Exhibit 25-19) S _R = mph (Exhibit 25-19) S ₀ = mph (Exhibit 25-19) S = mph (Exhibit 25-15)			

RAMPS AND RAMP JUNCTIONS WORKSHEET								
General Information			Site Information					
Analyst	MJW		Freeway/Dir of Travel	WB I-96				
Agency or Company	URS CORPORATION		Junction	M-100 OFF-RAMP				
Date Performed	02/01/2006		Jurisdiction	CLINTON COUNTY				
Analysis Time Period	PM PEAK		Analysis Year	2030 NO-BUILD				
Project Description I-96/M-100 INTERCHANGE STUDY								
Inputs								
Upstream Adj Ramp	Terrain Level					Downstream Adj Ramp		
<input type="checkbox"/> Yes <input type="checkbox"/> On						<input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On		
<input checked="" type="checkbox"/> No <input type="checkbox"/> Off						<input type="checkbox"/> No <input type="checkbox"/> Off		
L_{up} = ft						L_{down} = 1625 ft		
V _u = veh/h	$S_{FF} = 70.0 \text{ mph}$ $S_{FR} = 35.0 \text{ mph}$ Sketch (show lanes, L_A , L_D , V_R , V_f)					VD = 190 veh/h		
Conversion to pc/h Under Base Conditions								
(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f _{HV}	f _p	v=V/PHF f _{HV} f _p
Freeway	4010	0.90	Level	11	0	0.948	1.00	4701
Ramp	410	0.90	Level	2	0	0.990	1.00	460
UpStream								
DownStream	190	0.90	Level	3	0	0.985	1.00	214
Merge Areas					Diverge Areas			
Estimation of v_{12}					Estimation of v_{12}			
$V_{12} = V_F (P_{FM})$ $L_{EQ} = (\text{Equation 25-2 or 25-3})$ $P_{FM} = \text{using Equation}$ $V_{12} = \text{pc/h}$					$V_{12} = V_R + (V_F - V_R)P_{FD}$ $L_{EQ} = (\text{Equation 25-8 or 25-9})$ $P_{FD} = 1.000 \text{ using Equation 0}$ $V_{12} = 4701 \text{ pc/h}$			
Capacity Checks					Capacity Checks			
	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?	
V_{FO}	See Exhibit 25-7			$V_{FI}=V_F$	4701	4800	No	
				V_{12}	4701	4400:All	Yes	
V_{R12}	4600:All			$V_{FO} = V_F - V_R$	4241	4800	No	
				V_R	460	2000	No	
Level of Service Determination (if not F)				Level of Service Determination (if not F)				
$D_R = 5.475 + 0.00734 V_R + 0.0078 V_{12} - 0.00627 L_A$ $D_R = \text{(pc/ mi /ln)}$ $LOS = \text{(Exhibit 25-4)}$				$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$ $D_R = 40.2 \text{ (pc/ mi /ln)}$ $LOS = F \text{ (Exhibit 25-4)}$				
Speed Estimation				Speed Estimation				
$M_S = \text{(Exhibit 25-19)}$ $S_R = \text{mph (Exhibit 25-19)}$ $S_0 = \text{mph (Exhibit 25-19)}$ $S = \text{mph (Exhibit 25-14)}$				$D_S = 0.469 \text{ (Exhibit 25-19)}$ $S_R = 56.9 \text{ mph (Exhibit 25-19)}$ $S_0 = \text{N/A mph (Exhibit 25-19)}$ $S = 56.9 \text{ mph (Exhibit 25-15)}$				

RAMPS AND RAMP JUNCTIONS WORKSHEET								
General Information				Site Information				
Analyst2	MJW	Freeway/Dir of Travel	WB I-96					
Agency or Company	URS CORPORATION	Junction	M-100 ON-RAMP					
Date Performed	02/01/2006	Jurisdiction	CLINTON COUNTY					
Analysis Time Period	PM PEAK	Analysis Year	2030 NO-BUILD					
Project Description I-96/M-100 INTERCHANGE STUDY								
Inputs								
Upstream Adj Ramp	Terrain Level					Downstream Adj Ramp		
	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> On	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> Yes	<input type="checkbox"/> On	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Off
	L _{up} =	1625 ft				L _{down} =	ft	
V _u =	410 veh/h	S _{FF} = 70.0 mph S _{FR} = 35.0 mph			V _D =	veh/h	Sketch (show lanes, L _A , L _D , V _R , V _f)	
Conversion to pc/h Under Base Conditions								
(pc/h)	V (Veh/hr)	PHF	Terrain	Truck	%Rv	f _{HV}	f _p	v=V/PHF f _{HV} f _p
Freeway	3600	0.90	Level	11	0	0.948	1.00	4220
Ramp	200	0.90	Level	3	0	0.985	1.00	226
UpStream	410	0.90	Level	2	0	0.990	1.00	460
DownStream								
Merge Areas					Diverge Areas			
Estimation of v ₁₂					Estimation of v ₁₂			
V ₁₂ = V _F (P _{FM}) L _{EQ} = (Equation 25-2 or 25-3) P _{FM} = 1.000 using Equation 0 V ₁₂ = 4220 pc/h					V ₁₂ = V _R + (V _F - V _R)P _{FD} L _{EQ} = (Equation 25-8 or 25-9) P _{FD} = using Equation V ₁₂ = pc/h			
Capacity Checks					Capacity Checks			
	Actual	Maximum	LOS F?			Actual	Maximum	LOS F?
V _{FO}	4446	See Exhibit 25-7	No	V _{FI} =V _F		See Exhibit 25-14		
				V ₁₂		4400:All		
V _{R12}	4446	4600:All	No	V _{FO} = V _F - V _R		See Exhibit 25-14		
				V _R		See Exhibit 25-3		
Level of Service Determination (if not F)					Level of Service Determination (if not F)			
D _R = 5.475 + 0.00734 V _R + 0.0078 V ₁₂ - 0.00627 L _A D _R = 36.9 (pc/ m/in) LOS = E (Exhibit 25-4)					D _R = 4.252 + 0.0086 V ₁₂ - 0.009 L _D D _R = (pc/ m/in) LOS = (Exhibit 25-4)			
Speed Estimation					Speed Estimation			
M _S = 0.619 (Exhibit 25-19) S _R = 52.7 mph (Exhibit 25-19) S ₀ = N/A mph (Exhibit 25-19) S = 52.7 mph (Exhibit 25-14)					D _s = (Exhibit 25-19) S _R = mph (Exhibit 25-19) S ₀ = mph (Exhibit 25-19) S = mph (Exhibit 25-15)			

Appendix C

Build Future (2025) Conditions Capacity Analysis Worksheets

DIAMOND INTERCHANGE ALTERNATIVE

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0		4.0	4.0	4.0		4.0	4.0
Lane Util. Factor					1.00		1.00	1.00	1.00		1.00	1.00
Fr _t					1.00		0.85	1.00	1.00		1.00	0.85
Flt Protected					0.95		1.00	0.95	1.00		1.00	1.00
Satd. Flow (prot)					1597		1615	1641	1810		1863	1615
Flt Permitted					0.95		1.00	0.36	1.00		1.00	1.00
Satd. Flow (perm)					1597		1615	623	1810		1863	1615
Volume (vph)	0	0	0	115	0	40	145	60	0	0	425	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.92	0.69	0.79	0.63	0.92	0.92	0.88	0.42
Adj. Flow (vph)	0	0	0	158	0	58	184	95	0	0	483	48
RTOR Reduction (vph)	0	0	0	0	0	43	0	0	0	0	0	29
Lane Group Flow (vph)	0	0	0	158	0	15	184	95	0	0	483	19
Heavy Vehicles (%)	2%	2%	2%	13%	0%	0%	10%	5%	0%	2%	2%	0%
Turn Type				Prot		custom	custom					Perm
Protected Phases				6		6	3	3.8				4
Permitted Phases							8					4
Actuated Green, G (s)				16.0		16.0	28.0	28.0			24.0	24.0
Effective Green, g (s)				16.0		16.0	28.0	28.0			24.0	24.0
Actuated g/C Ratio				0.27		0.27	0.47	0.47			0.40	0.40
Clearance Time (s)				4.0		4.0	4.0				4.0	4.0
Lane Grp Cap (vph)				426		431	426	845			745	646
v/s Ratio Prot				c0.10		0.01	c0.06	0.05			c0.26	
v/s Ratio Perm							0.14					0.01
v/c Ratio				0.37		0.04	0.43	0.11			0.65	0.03
Uniform Delay, d1				17.9		16.3	9.9	9.0			14.6	10.9
Progression Factor				1.00		1.00	1.63	1.06			1.00	1.00
Incremental Delay, d2				2.5		0.2	3.0	0.3			4.3	0.1
Delay (s)				20.4		16.4	19.2	9.8			18.9	11.0
Level of Service				C		B	B	A			B	B
Approach Delay (s)	0.0				19.3			16.0			18.2	
Approach LOS	A				B			B			B	
Intersection Summary												
HCM Average Control Delay	17.8				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.52											
Actuated Cycle Length (s)	60.0				Sum of lost time (s)			12.0				
Intersection Capacity Utilization	46.8%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

2: EB I-96 off-ramp & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00			1.00				1.00	1.00	1.00	1.00	1.00
Fr _t	1.00			0.85				1.00	0.85	1.00	1.00	1.00
Flt Protected	0.95			1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805			1380				1712	1417	1770	1776	
Flt Permitted	0.95			1.00				1.00	1.00	0.47	1.00	
Satd. Flow (perm)	1805			1380				1712	1417	884	1776	
Volume (vph)	20	0	155	0	0	0	0	200	200	265	275	0
Peak-hour factor, PHF	0.50	0.92	0.82	0.92	0.92	0.92	0.92	0.90	0.87	0.75	0.88	0.92
Adj. Flow (vph)	40	0	189	0	0	0	0	222	230	353	312	0
RTOR Reduction (vph)	0	0	139	0	0	0	0	0	153	0	0	0
Lane Group Flow (vph)	40	0	50	0	0	0	0	222	77	353	312	0
Heavy Vehicles (%)	0%	2%	17%	2%	2%	2%	2%	11%	14%	2%	7%	2%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	16.0		16.0					20.0	20.0	36.0	36.0	
Effective Green, g (s)	16.0		16.0					20.0	20.0	36.0	36.0	
Actuated g/C Ratio	0.27		0.27					0.33	0.33	0.60	0.60	
Clearance Time (s)	4.0		4.0					4.0	4.0	4.0	4.0	
Lane Grp Cap (vph)	481		368					571	472	708	1066	
v/s Ratio Prot	0.02		c0.04					0.13		c0.10	0.18	
v/s Ratio Perm									0.05	c0.20		
v/c Ratio	0.08		0.14					0.39	0.16	0.50	0.29	
Uniform Delay, d1	16.5		16.7					15.3	14.1	6.4	5.8	
Progression Factor	1.00		1.00					1.00	1.00	1.59	1.33	
Incremental Delay, d2	0.3		0.8					2.0	0.7	2.0	0.6	
Delay (s)	16.8		17.5					17.3	14.8	12.2	8.4	
Level of Service	B		B					B	B	B	A	
Approach Delay (s)		17.4			0.0			16.1			10.4	
Approach LOS		B			A			B			B	
Intersection Summary												
HCM Average Control Delay	13.5		HCM Level of Service					B				
HCM Volume to Capacity ratio	0.38											
Actuated Cycle Length (s)	60.0		Sum of lost time (s)					8.0				
Intersection Capacity Utilization	46.8%		ICU Level of Service					A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

08/04/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control												
Volume (vph)												
Volume Total (vph)	20	120	60	145	35	95	30	235	170	130	305	10
Peak Hour Factor	0.70	0.98	0.58	0.73	0.79	0.79	0.63	0.77	0.77	0.73	0.78	0.25
Hourly flow rate (vph)	29	122	103	199	44	120	48	305	221	178	391	40
Direction, Lane #												
Volume Left (vph)	254	363	48	526	178	431						
Volume Right (vph)	29	199	48	0	178	0						
Hadj (s)	-0.10	0.10	0.58	-0.18	0.70	0.01						
Departure Headway (s)	9.0	8.7	9.3	8.6	9.4	8.7						
Degree Utilization, x	0.64	0.87	0.12	1.25	0.47	1.04						
Capacity (veh/h)	383	405	381	428	370	418						
Control Delay (s)	26.7	48.0	12.4	155.7	19.1	84.5						
Approach Delay (s)	26.7	48.0	143.8		65.4							
Approach LOS	D	E	F		F							
Intersection Summary												
Delay					81.4							
HCM Level of Service					F							
Intersection Capacity Utilization				70.0%		ICU Level of Service			C			
Analysis Period (min)				15								

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

03/23/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0		4.0	4.0	4.0		4.0	4.0
Lane Util. Factor					1.00		1.00	1.00	1.00		1.00	1.00
Fr _t					1.00		0.85	1.00	1.00		1.00	0.85
Flt Protected					0.95		1.00	0.95	1.00		1.00	1.00
Satd. Flow (prot)					1736		1615	1770	1900		1881	1292
Flt Permitted					0.95		1.00	0.64	1.00		1.00	1.00
Satd. Flow (perm)					1736		1615	1186	1900		1881	1292
Volume (vph)	0	0	0	165	0	245	180	175	0	0	175	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.84	0.92	0.86	0.91	0.84	0.92	0.92	0.91	0.50
Adj. Flow (vph)	0	0	0	196	0	285	198	208	0	0	192	40
RTOR Reduction (vph)	0	0	0	0	0	217	0	0	0	0	0	25
Lane Group Flow (vph)	0	0	0	196	0	68	198	208	0	0	192	15
Heavy Vehicles (%)	2%	2%	2%	4%	0%	0%	2%	0%	0%	2%	1%	25%
Turn Type				Prot		custom	custom					Perm
Protected Phases				6		6	3	3.8				4
Permitted Phases							8					4
Actuated Green, G (s)				10.2		10.2	22.4	28.2			17.2	17.2
Effective Green, g (s)				12.0		12.0	26.0	30.0			19.0	19.0
Actuated g/C Ratio				0.24		0.24	0.52	0.60			0.38	0.38
Clearance Time (s)				5.8		5.8	5.8				5.8	5.8
Lane Grp Cap (vph)				417		388	698	1140			715	491
v/s Ratio Prot				c0.11		0.04	c0.04	0.11			0.10	
v/s Ratio Perm							c0.11				0.01	
v/c Ratio				0.47		0.18	0.28	0.18			0.27	0.03
Uniform Delay, d1				16.3		15.1	6.9	4.5			10.7	9.7
Progression Factor				1.00		1.00	0.06	0.34			1.00	1.00
Incremental Delay, d2				3.8		1.0	0.9	0.3			0.9	0.1
Delay (s)				20.0		16.1	1.3	1.9			11.6	9.8
Level of Service				C		B	A	A			B	A
Approach Delay (s)	0.0				17.7			1.6			11.3	
Approach LOS	A				B			A			B	
Intersection Summary												
HCM Average Control Delay	10.5				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.34											
Actuated Cycle Length (s)	50.0				Sum of lost time (s)			12.0				
Intersection Capacity Utilization	41.6%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

2: EB I-96 off-ramp & M-100 (Wright Rd)

03/23/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00			1.00				1.00	1.00	1.00	1.00	1.00
Fr _t	1.00			0.85				1.00	0.85	1.00	1.00	1.00
Flt Protected	0.95			1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805			1599				1863	1538	1612	1827	
Flt Permitted	0.95			1.00				1.00	1.00	0.44	1.00	
Satd. Flow (perm)	1805			1599				1863	1538	748	1827	
Volume (vph)	25	0	140	0	0	0	0	340	160	100	240	0
Peak-hour factor, PHF	0.55	0.92	0.79	0.92	0.92	0.92	0.92	0.95	0.85	0.72	0.84	0.92
Adj. Flow (vph)	45	0	177	0	0	0	0	358	188	139	286	0
RTOR Reduction (vph)	0	0	135	0	0	0	0	0	117	0	0	0
Lane Group Flow (vph)	45	0	42	0	0	0	0	358	71	139	286	0
Heavy Vehicles (%)	0%	0%	1%	2%	2%	2%	2%	2%	5%	12%	4%	2%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	10.2		10.2					17.2	17.2	22.4	28.2	
Effective Green, g (s)	12.0		12.0					19.0	19.0	26.0	30.0	
Actuated g/C Ratio	0.24		0.24					0.38	0.38	0.52	0.60	
Clearance Time (s)	5.8		5.8					5.8	5.8	5.8		
Lane Grp Cap (vph)	433		384					708	584	510	1096	
v/s Ratio Prot	0.02		c0.03					c0.19		0.04	c0.16	
v/s Ratio Perm									0.05	0.10		
v/c Ratio	0.10		0.11					0.51	0.12	0.27	0.26	
Uniform Delay, d1	14.8		14.8					11.9	10.1	9.0	4.7	
Progression Factor	1.00		1.00					1.00	1.00	0.29	1.19	
Incremental Delay, d2	0.5		0.6					2.6	0.4	1.3	0.5	
Delay (s)	15.3		15.4					14.5	10.5	3.9	6.2	
Level of Service	B		B					B	B	A	A	
Approach Delay (s)		15.4			0.0			13.1		5.4		
Approach LOS		B			A			B		A		
Intersection Summary												
HCM Average Control Delay	10.8				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.32											
Actuated Cycle Length (s)	50.0				Sum of lost time (s)			8.0				
Intersection Capacity Utilization	41.6%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

03/23/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	45	30	160	160	150	80	310	115	70	255	30
Peak Hour Factor	0.70	0.98	0.58	0.73	0.79	0.79	0.63	0.77	0.77	0.73	0.78	0.25
Hourly flow rate (vph)	29	46	52	219	203	190	127	403	149	96	327	120
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total (vph)	126	612	127	552	96	447						
Volume Left (vph)	29	219	127	0	96	0						
Volume Right (vph)	52	190	0	149	0	120						
Hadj (s)	0.00	0.10	0.58	-0.06	0.70	-0.13						
Departure Headway (s)	9.5	7.9	8.9	8.2	9.0	8.2						
Degree Utilization, x	0.33	1.34	0.31	1.26	0.24	1.01						
Capacity (veh/h)	377	455	402	445	396	447						
Control Delay (s)	17.1	189.3	14.6	158.5	13.6	74.3						
Approach Delay (s)	17.1	189.3	131.6		63.5							
Approach LOS	C	F	F		F							
Intersection Summary												
Delay					123.4							
HCM Level of Service					F							
Intersection Capacity Utilization				70.3%		ICU Level of Service				C		
Analysis Period (min)				15								

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0		4.0	4.0	4.0		4.0	4.0
Lane Util. Factor					1.00		1.00	1.00	1.00		1.00	1.00
Fr _t					1.00		0.85	1.00	1.00		1.00	0.85
Flt Protected					0.95		1.00	0.95	1.00		1.00	1.00
Satd. Flow (prot)					1597		1615	1641	1810		1863	1615
Flt Permitted					0.95		1.00	0.36	1.00		1.00	1.00
Satd. Flow (perm)					1597		1615	623	1810		1863	1615
Volume (vph)	0	0	0	115	0	40	145	60	0	0	425	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.92	0.69	0.79	0.63	0.92	0.92	0.88	0.42
Adj. Flow (vph)	0	0	0	158	0	58	184	95	0	0	483	48
RTOR Reduction (vph)	0	0	0	0	0	43	0	0	0	0	0	29
Lane Group Flow (vph)	0	0	0	158	0	15	184	95	0	0	483	19
Heavy Vehicles (%)	2%	2%	2%	13%	0%	0%	10%	5%	0%	2%	2%	0%
Turn Type				Prot		custom	custom					Perm
Protected Phases				6		6	3	3.8				4
Permitted Phases							8					4
Actuated Green, G (s)				16.0		16.0	28.0	28.0			24.0	24.0
Effective Green, g (s)				16.0		16.0	28.0	28.0			24.0	24.0
Actuated g/C Ratio				0.27		0.27	0.47	0.47			0.40	0.40
Clearance Time (s)				4.0		4.0	4.0				4.0	4.0
Lane Grp Cap (vph)				426		431	426	845			745	646
v/s Ratio Prot				c0.10		0.01	c0.06	0.05			c0.26	
v/s Ratio Perm							0.14					0.01
v/c Ratio				0.37		0.04	0.43	0.11			0.65	0.03
Uniform Delay, d1				17.9		16.3	9.9	9.0			14.6	10.9
Progression Factor				1.00		1.00	1.64	0.97			1.00	1.00
Incremental Delay, d2				2.5		0.2	3.0	0.3			4.3	0.1
Delay (s)				20.4		16.4	19.3	9.0			18.9	11.0
Level of Service				C		B	B	A			B	B
Approach Delay (s)	0.0				19.3			15.8			18.2	
Approach LOS	A				B			B			B	
Intersection Summary												
HCM Average Control Delay	17.8				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.52											
Actuated Cycle Length (s)	60.0				Sum of lost time (s)			12.0				
Intersection Capacity Utilization	46.8%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

2: EB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00			1.00				1.00	1.00	1.00	1.00	
Fr _t	1.00			0.85				1.00	0.85	1.00	1.00	
Flt Protected	0.95			1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805			1380				1712	1417	1770	1776	
Flt Permitted	0.95			1.00				1.00	1.00	0.47	1.00	
Satd. Flow (perm)	1805			1380				1712	1417	884	1776	
Volume (vph)	20	0	155	0	0	0	0	200	200	265	275	0
Peak-hour factor, PHF	0.50	0.92	0.82	0.92	0.92	0.92	0.92	0.90	0.87	0.75	0.88	0.92
Adj. Flow (vph)	40	0	189	0	0	0	0	222	230	353	312	0
RTOR Reduction (vph)	0	0	139	0	0	0	0	0	153	0	0	0
Lane Group Flow (vph)	40	0	50	0	0	0	0	222	77	353	312	0
Heavy Vehicles (%)	0%	2%	17%	2%	2%	2%	2%	11%	14%	2%	7%	2%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	16.0		16.0					20.0	20.0	36.0	36.0	
Effective Green, g (s)	16.0		16.0					20.0	20.0	36.0	36.0	
Actuated g/C Ratio	0.27		0.27					0.33	0.33	0.60	0.60	
Clearance Time (s)	4.0		4.0					4.0	4.0	4.0	4.0	
Lane Grp Cap (vph)	481		368					571	472	708	1066	
v/s Ratio Prot	0.02		c0.04					0.13		c0.10	0.18	
v/s Ratio Perm									0.05	c0.20		
v/c Ratio	0.08		0.14					0.39	0.16	0.50	0.29	
Uniform Delay, d1	16.5		16.7					15.3	14.1	6.4	5.8	
Progression Factor	1.00		1.00					0.97	1.83	1.59	1.33	
Incremental Delay, d2	0.3		0.8					1.8	0.7	2.0	0.6	
Delay (s)	16.8		17.5					16.6	26.5	12.2	8.4	
Level of Service	B		B					B	C	B	A	
Approach Delay (s)		17.4			0.0			21.6			10.4	
Approach LOS		B			A			C			B	
Intersection Summary												
HCM Average Control Delay	15.4				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.38											
Actuated Cycle Length (s)	60.0				Sum of lost time (s)			8.0				
Intersection Capacity Utilization	46.8%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↑	↓		↑	↓		↑	↓		↑	↓	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Fr _t	1.00	0.93		1.00	0.89		1.00	0.94		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1262	1727		1671	1465		1719	1672		1612	1792	
Flt Permitted	0.65	1.00		0.57	1.00		0.43	1.00		0.35	1.00	
Satd. Flow (perm)	868	1727		1006	1465		773	1672		591	1792	
Volume (vph)	20	120	60	145	35	95	30	235	170	130	305	10
Peak-hour factor, PHF	0.70	0.98	0.58	0.73	0.79	0.79	0.63	0.77	0.77	0.73	0.78	0.25
Adj. Flow (vph)	29	122	103	199	44	120	48	305	221	178	391	40
RTOR Reduction (vph)	0	51	0	0	78	0	0	44	0	0	6	0
Lane Group Flow (vph)	29	174	0	199	86	0	48	483	0	178	425	0
Heavy Vehicles (%)	43%	2%	3%	8%	14%	16%	5%	9%	3%	12%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	19.2	19.2		19.2	19.2		29.2	29.2		29.2	29.2	
Effective Green, g (s)	21.0	21.0		21.0	21.0		31.0	31.0		31.0	31.0	
Actuated g/C Ratio	0.35	0.35		0.35	0.35		0.52	0.52		0.52	0.52	
Clearance Time (s)	5.8	5.8		5.8	5.8		5.8	5.8		5.8	5.8	
Lane Grp Cap (vph)	304	604		352	513		399	864		305	926	
v/s Ratio Prot	0.10			0.06			0.29			0.24		
v/s Ratio Perm	0.03		c0.20			0.06			c0.30			
v/c Ratio	0.10	0.29		0.57	0.17		0.12	0.56		0.58	0.46	
Uniform Delay, d1	13.1	14.1		15.8	13.5		7.5	9.9		10.0	9.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		0.85	0.80	
Incremental Delay, d2	0.6	1.2		6.4	0.7		0.6	2.6		7.8	1.6	
Delay (s)	13.7	15.3		22.2	14.2		8.1	12.5		16.3	9.0	
Level of Service	B	B		C	B		A	B		B	A	
Approach Delay (s)		15.1			18.6			12.1			11.1	
Approach LOS		B			B			B			B	
Intersection Summary												
HCM Average Control Delay		13.5			HCM Level of Service			B				
HCM Volume to Capacity ratio		0.58										
Actuated Cycle Length (s)		60.0			Sum of lost time (s)			8.0				
Intersection Capacity Utilization		61.3%			ICU Level of Service			B				
Analysis Period (min)		15										
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0		4.0	4.0	4.0		4.0	4.0
Lane Util. Factor					1.00		1.00	1.00	1.00		1.00	1.00
Fr _t					1.00		0.85	1.00	1.00		1.00	0.85
Flt Protected					0.95		1.00	0.95	1.00		1.00	1.00
Satd. Flow (prot)					1736		1615	1770	1900		1881	1292
Flt Permitted					0.95		1.00	0.64	1.00		1.00	1.00
Satd. Flow (perm)					1736		1615	1186	1900		1881	1292
Volume (vph)	0	0	0	165	0	245	180	175	0	0	175	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.84	0.92	0.86	0.91	0.84	0.92	0.92	0.91	0.50
Adj. Flow (vph)	0	0	0	196	0	285	198	208	0	0	192	40
RTOR Reduction (vph)	0	0	0	0	0	194	0	0	0	0	0	26
Lane Group Flow (vph)	0	0	0	196	0	91	198	208	0	0	192	14
Heavy Vehicles (%)	2%	2%	2%	4%	0%	0%	2%	0%	0%	2%	1%	25%
Turn Type				Prot		custom	custom					Perm
Protected Phases				6		6	3	3.8				4
Permitted Phases							8					4
Actuated Green, G (s)				16.0		16.0	22.0	26.0			17.0	17.0
Effective Green, g (s)				16.0		16.0	22.0	26.0			17.0	17.0
Actuated g/C Ratio				0.32		0.32	0.44	0.52			0.34	0.34
Clearance Time (s)				4.0		4.0	4.0				4.0	4.0
Lane Grp Cap (vph)				556		517	580	988			640	439
v/s Ratio Prot				c0.11		0.06	c0.03	0.11			0.10	
v/s Ratio Perm							c0.12				0.01	
v/c Ratio				0.35		0.18	0.34	0.21			0.30	0.03
Uniform Delay, d1				13.0		12.3	8.8	6.5			12.1	11.0
Progression Factor				1.00		1.00	0.75	0.98			1.00	1.00
Incremental Delay, d2				1.8		0.7	1.3	0.4			1.2	0.1
Delay (s)				14.8		13.0	8.0	6.8			13.3	11.1
Level of Service				B		B	A	A			B	B
Approach Delay (s)	0.0				13.7			7.4			13.0	
Approach LOS	A				B			A			B	
Intersection Summary												
HCM Average Control Delay	11.3				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.35											
Actuated Cycle Length (s)	50.0				Sum of lost time (s)			12.0				
Intersection Capacity Utilization	38.3%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

2: EB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00			1.00				1.00	1.00	1.00	1.00	1.00
Fr _t	1.00			0.85				1.00	0.85	1.00	1.00	1.00
Flt Protected	0.95			1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805			1599				1863	1538	1612	1827	
Flt Permitted	0.95			1.00				1.00	1.00	0.41	1.00	
Satd. Flow (perm)	1805			1599				1863	1538	699	1827	
Volume (vph)	25	0	140	0	0	0	0	340	160	100	240	0
Peak-hour factor, PHF	0.55	0.92	0.79	0.92	0.92	0.92	0.92	0.95	0.85	0.72	0.84	0.92
Adj. Flow (vph)	45	0	177	0	0	0	0	358	188	139	286	0
RTOR Reduction (vph)	0	0	120	0	0	0	0	0	124	0	0	0
Lane Group Flow (vph)	45	0	57	0	0	0	0	358	64	139	286	0
Heavy Vehicles (%)	0%	0%	1%	2%	2%	2%	2%	2%	5%	12%	4%	2%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	16.0		16.0					17.0	17.0	22.0	26.0	
Effective Green, g (s)	16.0		16.0					17.0	17.0	22.0	26.0	
Actuated g/C Ratio	0.32		0.32					0.34	0.34	0.44	0.52	
Clearance Time (s)	4.0		4.0					4.0	4.0	4.0		
Lane Grp Cap (vph)	578		512					633	523	399	950	
v/s Ratio Prot	0.02		c0.04					c0.19		0.03	c0.16	
v/s Ratio Perm									0.04	0.12		
v/c Ratio	0.08		0.11					0.57	0.12	0.35	0.30	
Uniform Delay, d1	11.9		12.0					13.5	11.4	8.8	6.8	
Progression Factor	1.00		1.00					0.78	0.79	0.85	1.30	
Incremental Delay, d2	0.3		0.4					2.8	0.4	2.4	0.8	
Delay (s)	12.1		12.4					13.3	9.4	9.8	9.7	
Level of Service	B		B					B	A	A	A	
Approach Delay (s)		12.4			0.0			11.9			9.7	
Approach LOS		B			A			B			A	
Intersection Summary												
HCM Average Control Delay	11.2				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.35											
Actuated Cycle Length (s)	50.0				Sum of lost time (s)			12.0				
Intersection Capacity Utilization	38.3%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↑	↓		↑	↓		↑	↓		↑	↓	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Fr _t	1.00	0.92		1.00	0.93		1.00	0.96		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1262	1706		1671	1533		1719	1698		1612	1759	
Flt Permitted	0.40	1.00		0.69	1.00		0.40	1.00		0.30	1.00	
Satd. Flow (perm)	531	1706		1220	1533		717	1698		508	1759	
Volume (vph)	20	45	30	160	160	150	80	310	115	70	255	30
Peak-hour factor, PHF	0.70	0.98	0.58	0.73	0.79	0.79	0.63	0.77	0.77	0.73	0.78	0.25
Adj. Flow (vph)	29	46	52	219	203	190	127	403	149	96	327	120
RTOR Reduction (vph)	0	32	0	0	68	0	0	26	0	0	26	0
Lane Group Flow (vph)	29	66	0	219	325	0	127	526	0	96	421	0
Heavy Vehicles (%)	43%	2%	3%	8%	14%	16%	5%	9%	3%	12%	5%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	17.2	17.2		17.2	17.2		21.2	21.2		21.2	21.2	
Effective Green, g (s)	19.0	19.0		19.0	19.0		23.0	23.0		23.0	23.0	
Actuated g/C Ratio	0.38	0.38		0.38	0.38		0.46	0.46		0.46	0.46	
Clearance Time (s)	5.8	5.8		5.8	5.8		5.8	5.8		5.8	5.8	
Lane Grp Cap (vph)	202	648		464	583		330	781		234	809	
v/s Ratio Prot	0.04			c0.21			c0.31			0.24		
v/s Ratio Perm	0.05			0.18			0.18			0.19		
v/c Ratio	0.14	0.10		0.47	0.56		0.38	0.67		0.41	0.52	
Uniform Delay, d1	10.2	10.0		11.7	12.2		8.9	10.6		9.0	9.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		0.71	0.62	
Incremental Delay, d2	1.5	0.3		3.4	3.8		3.4	4.6		5.2	2.3	
Delay (s)	11.7	10.3		15.1	16.0		12.2	15.2		11.5	8.3	
Level of Service	B	B		B	B		B	B		B	A	
Approach Delay (s)		10.6			15.7			14.6			8.9	
Approach LOS		B			B			B			A	
Intersection Summary												
HCM Average Control Delay	13.1			HCM Level of Service			B					
HCM Volume to Capacity ratio	0.62											
Actuated Cycle Length (s)	50.0			Sum of lost time (s)			8.0					
Intersection Capacity Utilization	54.8%			ICU Level of Service			A					
Analysis Period (min)	15											
c Critical Lane Group												

PARCLO ALTERNATIVE

HCM Unsignalized Intersection Capacity Analysis

1: WB I-96 ON-RAMP & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	115	145	115	425	20
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	125	158	125	462	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh						
Upstream signal (ft)			1033			
pX, platoon unblocked						
vC, conflicting volume	902	462	484			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	902	462	484			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	79	85			
cM capacity (veh/h)	263	600	1079			
Direction, Lane #	EB 1	NB 1	NB 2	SB 1	SB 2	
Volume Total	125	158	125	462	22	
Volume Left	0	158	0	0	0	
Volume Right	125	0	0	0	22	
cSH	600	1079	1700	1700	1700	
Volume to Capacity	0.21	0.15	0.07	0.27	0.01	
Queue Length 95th (ft)	19	13	0	0	0	
Control Delay (s)	12.6	8.9	0.0	0.0	0.0	
Lane LOS	B	A				
Approach Delay (s)	12.6	5.0		0.0		
Approach LOS	B					
Intersection Summary						
Average Delay		3.3				
Intersection Capacity Utilization	37.1%		ICU Level of Service		A	
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis

2: WB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations			↑			↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	40	220	0	0	540
Peak Hour Factor	0.84	0.86	0.84	0.92	0.92	0.91
Hourly flow rate (vph)	0	47	262	0	0	593
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh						
Upstream signal (ft)			568			
pX, platoon unblocked	0.94	0.94			0.94	
vC, conflicting volume	855	262			262	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	845	212			212	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	94			100	
cM capacity (veh/h)	309	780			1283	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	47	262	593			
Volume Left	0	0	0			
Volume Right	47	0	0			
cSH	780	1700	1700			
Volume to Capacity	0.06	0.15	0.35			
Queue Length 95th (ft)	5	0	0			
Control Delay (s)	9.9	0.0	0.0			
Lane LOS	A					
Approach Delay (s)	9.9	0.0	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			0.5			
Intersection Capacity Utilization		43.0%		ICU Level of Service		A
Analysis Period (min)		15				

HCM Signalized Intersection Capacity Analysis

3: EB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00			1.00				1.00	1.00	1.00	1.00	1.00
Fr _t	1.00			0.85				1.00	0.85	1.00	1.00	1.00
Flt Protected	0.95			1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805			1599				1863	1538	1612	1827	
Flt Permitted	0.95			1.00				1.00	1.00	0.61	1.00	
Satd. Flow (perm)	1805			1599				1863	1538	1042	1827	
Volume (vph)	20	0	155	0	0	0	0	200	200	265	275	0
Peak-hour factor, PHF	0.55	0.92	0.79	0.92	0.92	0.92	0.92	0.95	0.85	0.72	0.84	0.92
Adj. Flow (vph)	36	0	196	0	0	0	0	211	235	368	327	0
RTOR Reduction (vph)	0	0	153	0	0	0	0	0	155	0	0	0
Lane Group Flow (vph)	36	0	43	0	0	0	0	211	80	368	327	0
Heavy Vehicles (%)	0%	0%	1%	0%	0%	0%	0%	2%	5%	12%	4%	0%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	9.2		9.2					15.2	15.2	29.2	29.2	
Effective Green, g (s)	11.0		11.0					17.0	17.0	31.0	31.0	
Actuated g/C Ratio	0.22		0.22					0.34	0.34	0.62	0.62	
Clearance Time (s)	5.8		5.8					5.8	5.8	5.8	5.8	
Lane Grp Cap (vph)	397		352					633	523	760	1133	
v/s Ratio Prot	0.02		c0.03					0.11		c0.10	0.18	
v/s Ratio Perm									0.05	c0.20		
v/c Ratio	0.09		0.12					0.33	0.15	0.48	0.29	
Uniform Delay, d1	15.5		15.6					12.3	11.5	5.7	4.4	
Progression Factor	1.00		1.00					1.00	1.00	0.91	0.97	
Incremental Delay, d2	0.5		0.7					1.4	0.6	2.2	0.6	
Delay (s)	16.0		16.3					13.7	12.1	7.4	4.9	
Level of Service	B		B					B	B	A	A	
Approach Delay (s)		16.3			0.0			12.9			6.2	
Approach LOS		B			A			B			A	
Intersection Summary												
HCM Average Control Delay	10.1				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.38											
Actuated Cycle Length (s)	50.0				Sum of lost time (s)			8.0				
Intersection Capacity Utilization	43.0%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

4: Grand River Ave & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control												
Volume (vph)												
Volume Total (vph)	20	120	60	145	35	95	30	235	170	130	305	10
Peak Hour Factor	0.60	0.65	0.79	0.74	0.74	0.90	0.70	0.81	0.84	0.74	0.92	0.64
Hourly flow rate (vph)	33	185	76	196	47	106	43	290	202	176	332	16
Direction, Lane #												
Volume Left (vph)	294	349	43	493	176	347						
Volume Right (vph)	33	196	43	0	176	0						
Hadj (s)	-0.03	-0.03	0.50	-0.28	0.64	0.00						
Departure Headway (s)	8.8	8.5	9.3	8.5	9.4	8.7						
Degree Utilization, x	0.71	0.82	0.11	1.17	0.46	0.84						
Capacity (veh/h)	394	410	380	427	368	405						
Control Delay (s)	30.9	40.5	12.3	124.1	18.9	42.7						
Approach Delay (s)	30.9	40.5	115.2		34.7							
Approach LOS	D	E	F		D							
Intersection Summary												
Delay					60.6							
HCM Level of Service					F							
Intersection Capacity Utilization				70.0%		ICU Level of Service			C			
Analysis Period (min)				15								

HCM Unsignalized Intersection Capacity Analysis

1: WB I-96 ON-RAMP & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	165	180	430	175	20
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	179	196	467	190	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh						
Upstream signal (ft)			1033			
pX, platoon unblocked						
vC, conflicting volume	1049	190	212			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1049	190	212			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	79	86			
cM capacity (veh/h)	216	852	1358			
Direction, Lane #	EB 1	NB 1	NB 2	SB 1	SB 2	
Volume Total	179	196	467	190	22	
Volume Left	0	196	0	0	0	
Volume Right	179	0	0	0	22	
cSH	852	1358	1700	1700	1700	
Volume to Capacity	0.21	0.14	0.27	0.11	0.01	
Queue Length 95th (ft)	20	13	0	0	0	
Control Delay (s)	10.4	8.1	0.0	0.0	0.0	
Lane LOS	B	A				
Approach Delay (s)	10.4	2.4		0.0		
Approach LOS	B					
Intersection Summary						
Average Delay		3.3				
Intersection Capacity Utilization	26.1%		ICU Level of Service		A	
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis

2: WB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations			↑			↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	245	365	0	0	340
Peak Hour Factor	0.84	0.86	0.84	0.92	0.92	0.91
Hourly flow rate (vph)	0	285	435	0	0	374
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh						
Upstream signal (ft)		568				
pX, platoon unblocked	0.86	0.86		0.86		
vC, conflicting volume	808	435		435		
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	777	342		342		
tC, single (s)	6.4	6.2		4.1		
tC, 2 stage (s)						
tF (s)	3.5	3.3		2.2		
p0 queue free %	100	53		100		
cM capacity (veh/h)	312	606		1056		
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	285	435	374			
Volume Left	0	0	0			
Volume Right	285	0	0			
cSH	606	1700	1700			
Volume to Capacity	0.47	0.26	0.22			
Queue Length 95th (ft)	63	0	0			
Control Delay (s)	16.1	0.0	0.0			
Lane LOS	C					
Approach Delay (s)	16.1	0.0	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay		4.2				
Intersection Capacity Utilization		41.0%	ICU Level of Service		A	
Analysis Period (min)		15				

HCM Signalized Intersection Capacity Analysis

3: EB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006

Movement	EBL	EBT	EBC	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00			1.00				1.00	1.00	1.00	1.00	1.00
Fr _t	1.00			0.85				1.00	0.85	1.00	1.00	1.00
Flt Protected	0.95			1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805			1599				1863	1538	1612	1827	
Flt Permitted	0.95			1.00				1.00	1.00	0.47	1.00	
Satd. Flow (perm)	1805			1599				1863	1538	795	1827	
Volume (vph)	25	0	140	0	0	0	0	340	160	100	240	0
Peak-hour factor, PHF	0.55	0.92	0.79	0.92	0.92	0.92	0.92	0.95	0.85	0.72	0.84	0.92
Adj. Flow (vph)	45	0	177	0	0	0	0	358	188	139	286	0
RTOR Reduction (vph)	0	0	138	0	0	0	0	0	113	0	0	0
Lane Group Flow (vph)	45	0	39	0	0	0	0	358	75	139	286	0
Heavy Vehicles (%)	0%	0%	1%	0%	0%	0%	0%	2%	5%	12%	4%	0%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	9.2		9.2					18.2	18.2	29.2	29.2	
Effective Green, g (s)	11.0		11.0					20.0	20.0	31.0	31.0	
Actuated g/C Ratio	0.22		0.22					0.40	0.40	0.62	0.62	
Clearance Time (s)	5.8		5.8					5.8	5.8	5.8	5.8	
Lane Grp Cap (vph)	397		352					745	615	607	1133	
v/s Ratio Prot	c0.02		0.02					c0.19		0.03	c0.16	
v/s Ratio Perm									0.05	0.11		
v/c Ratio	0.11		0.11					0.48	0.12	0.23	0.25	
Uniform Delay, d1	15.6		15.6					11.1	9.5	5.9	4.3	
Progression Factor	1.00		1.00					1.00	1.00	0.96	0.97	
Incremental Delay, d2	0.6		0.6					2.2	0.4	0.9	0.5	
Delay (s)	16.2		16.2					13.4	9.9	6.6	4.7	
Level of Service	B		B					B	A	A	A	
Approach Delay (s)		16.2			0.0			12.2			5.3	
Approach LOS		B			A			B			A	
Intersection Summary												
HCM Average Control Delay	10.5				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.32											
Actuated Cycle Length (s)	50.0				Sum of lost time (s)			8.0				
Intersection Capacity Utilization	41.0%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

4: Grand River Ave & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control												
Volume (vph)												
Volume Total (vph)	20	45	30	160	160	150	80	310	115	70	255	30
Peak Hour Factor	0.60	0.65	0.79	0.74	0.74	0.90	0.70	0.81	0.84	0.74	0.92	0.64
Hourly flow rate (vph)	33	69	38	216	216	167	114	383	137	95	277	47
Direction, Lane #												
Volume Left (vph)	141	599	114	520	95	324						
Volume Right (vph)	33	216	114	0	95	0						
Hadj (s)	8.9	7.4	8.5	7.8	9.0	8.2						
Departure Headway (s)	0.35	1.23	0.27	1.13	0.24	0.74						
Degree Utilization, x	389	478	419	464	396	428						
Capacity (veh/h)	16.7	145.1	13.4	107.8	13.5	30.3						
Control Delay (s)	16.7	145.1	90.8		26.5							
Approach Delay (s)	C	F	F		D							
Intersection Summary												
Delay							88.1					
HCM Level of Service							F					
Intersection Capacity Utilization				70.3%			ICU Level of Service					C
Analysis Period (min)							15					

HCM Unsignalized Intersection Capacity Analysis

1: WB I-96 ON-RAMP & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	115	145	115	425	20
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	125	158	125	462	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh						
Upstream signal (ft)			1033			
pX, platoon unblocked						
vC, conflicting volume	902	462	484			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	902	462	484			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	79	85			
cM capacity (veh/h)	263	600	1079			
Direction, Lane #	EB 1	NB 1	NB 2	SB 1	SB 2	
Volume Total	125	158	125	462	22	
Volume Left	0	158	0	0	0	
Volume Right	125	0	0	0	22	
cSH	600	1079	1700	1700	1700	
Volume to Capacity	0.21	0.15	0.07	0.27	0.01	
Queue Length 95th (ft)	19	13	0	0	0	
Control Delay (s)	12.6	8.9	0.0	0.0	0.0	
Lane LOS	B	A				
Approach Delay (s)	12.6	5.0		0.0		
Approach LOS	B					
Intersection Summary						
Average Delay		3.3				
Intersection Capacity Utilization	37.1%		ICU Level of Service		A	
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis

2: WB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations			↑			↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	40	220	0	0	540
Peak Hour Factor	0.84	0.86	0.84	0.92	0.92	0.91
Hourly flow rate (vph)	0	47	262	0	0	593
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh						
Upstream signal (ft)			568			
pX, platoon unblocked	0.94	0.94			0.94	
vC, conflicting volume	855	262			262	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	845	212			212	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	94			100	
cM capacity (veh/h)	309	780			1283	
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	47	262	593			
Volume Left	0	0	0			
Volume Right	47	0	0			
cSH	780	1700	1700			
Volume to Capacity	0.06	0.15	0.35			
Queue Length 95th (ft)	5	0	0			
Control Delay (s)	9.9	0.0	0.0			
Lane LOS	A					
Approach Delay (s)	9.9	0.0	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay			0.5			
Intersection Capacity Utilization		43.0%		ICU Level of Service		A
Analysis Period (min)		15				

HCM Signalized Intersection Capacity Analysis

3: EB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00			1.00				1.00	1.00	1.00	1.00	1.00
Fr _t	1.00			0.85				1.00	0.85	1.00	1.00	1.00
Flt Protected	0.95			1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805			1599				1863	1538	1612	1827	
Flt Permitted	0.95			1.00				1.00	1.00	0.61	1.00	
Satd. Flow (perm)	1805			1599				1863	1538	1042	1827	
Volume (vph)	20	0	155	0	0	0	0	200	200	265	275	0
Peak-hour factor, PHF	0.55	0.92	0.79	0.92	0.92	0.92	0.92	0.95	0.85	0.72	0.84	0.92
Adj. Flow (vph)	36	0	196	0	0	0	0	211	235	368	327	0
RTOR Reduction (vph)	0	0	153	0	0	0	0	0	155	0	0	0
Lane Group Flow (vph)	36	0	43	0	0	0	0	211	80	368	327	0
Heavy Vehicles (%)	0%	0%	1%	0%	0%	0%	0%	2%	5%	12%	4%	0%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	9.2		9.2					16.2	16.2	29.2	29.2	
Effective Green, g (s)	11.0		11.0					17.0	17.0	31.0	31.0	
Actuated g/C Ratio	0.22		0.22					0.34	0.34	0.62	0.62	
Clearance Time (s)	5.8		5.8					4.8	4.8	5.8	5.8	
Lane Grp Cap (vph)	397		352					633	523	760	1133	
v/s Ratio Prot	0.02		c0.03					0.11		c0.10	0.18	
v/s Ratio Perm									0.05	c0.20		
v/c Ratio	0.09		0.12					0.33	0.15	0.48	0.29	
Uniform Delay, d1	15.5		15.6					12.3	11.5	5.7	4.4	
Progression Factor	1.00		1.00					0.98	1.77	0.91	0.97	
Incremental Delay, d2	0.5		0.7					1.3	0.6	2.2	0.6	
Delay (s)	16.0		16.3					13.3	20.9	7.4	4.9	
Level of Service	B		B					B	C	A	A	
Approach Delay (s)		16.3			0.0			17.3			6.2	
Approach LOS		B			A			B			A	
Intersection Summary												
HCM Average Control Delay	11.5			HCM Level of Service				B				
HCM Volume to Capacity ratio	0.38											
Actuated Cycle Length (s)	50.0			Sum of lost time (s)				8.0				
Intersection Capacity Utilization	43.0%			ICU Level of Service				A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

4: Grand River Ave & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↑ ↗	↑ ↘		↑ ↗	↑ ↘		↑ ↗	↑ ↘		↑ ↗	↑ ↘	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Fr _t	1.00	0.96		1.00	0.90		1.00	0.94		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1444	1754		1770	1653		1805	1773		1671	1852	
Flt Permitted	0.66	1.00		0.55	1.00		0.50	1.00		0.37	1.00	
Satd. Flow (perm)	1003	1754		1026	1653		952	1773		646	1852	
Volume (vph)	20	120	60	145	35	95	30	235	170	130	305	10
Peak-hour factor, PHF	0.60	0.65	0.79	0.74	0.74	0.90	0.70	0.81	0.84	0.74	0.92	0.64
Adj. Flow (vph)	33	185	76	196	47	106	43	290	202	176	332	16
RTOR Reduction (vph)	0	29	0	0	68	0	0	50	0	0	4	0
Lane Group Flow (vph)	33	232	0	196	85	0	43	442	0	176	344	0
Heavy Vehicles (%)	25%	3%	5%	2%	3%	3%	0%	1%	0%	8%	2%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	16.2	16.2		16.2	16.2		22.2	22.2		22.2	22.2	
Effective Green, g (s)	18.0	18.0		18.0	18.0		24.0	24.0		24.0	24.0	
Actuated g/C Ratio	0.36	0.36		0.36	0.36		0.48	0.48		0.48	0.48	
Clearance Time (s)	5.8	5.8		5.8	5.8		5.8	5.8		5.8	5.8	
Lane Grp Cap (vph)	361	631		369	595		457	851		310	889	
v/s Ratio Prot	0.13			0.05			0.25			0.19		
v/s Ratio Perm	0.03		c0.19			0.05			c0.27			
v/c Ratio	0.09	0.37		0.53	0.14		0.09	0.52		0.57	0.39	
Uniform Delay, d ₁	10.6	11.8		12.7	10.8		7.1	9.0		9.3	8.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.09	1.10	
Incremental Delay, d ₂	0.5	1.6		5.4	0.5		0.4	2.3		7.1	1.2	
Delay (s)	11.1	13.4		18.0	11.3		7.5	11.3		17.2	10.4	
Level of Service	B	B		B	B		A	B		B	B	
Approach Delay (s)		13.2			15.1			11.0			12.7	
Approach LOS		B			B			B			B	
Intersection Summary												
HCM Average Control Delay		12.7			HCM Level of Service			B				
HCM Volume to Capacity ratio		0.55										
Actuated Cycle Length (s)		50.0			Sum of lost time (s)			8.0				
Intersection Capacity Utilization		61.3%			ICU Level of Service			B				
Analysis Period (min)		15										
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

1: WB I-96 ON-RAMP & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	165	180	430	175	20
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	179	196	467	190	22
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh						
Upstream signal (ft)			1033			
pX, platoon unblocked						
vC, conflicting volume	1049	190	212			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1049	190	212			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	79	86			
cM capacity (veh/h)	216	852	1358			
Direction, Lane #	EB 1	NB 1	NB 2	SB 1	SB 2	
Volume Total	179	196	467	190	22	
Volume Left	0	196	0	0	0	
Volume Right	179	0	0	0	22	
cSH	852	1358	1700	1700	1700	
Volume to Capacity	0.21	0.14	0.27	0.11	0.01	
Queue Length 95th (ft)	20	13	0	0	0	
Control Delay (s)	10.4	8.1	0.0	0.0	0.0	
Lane LOS	B	A				
Approach Delay (s)	10.4	2.4		0.0		
Approach LOS	B					
Intersection Summary						
Average Delay		3.3				
Intersection Capacity Utilization	26.1%		ICU Level of Service		A	
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis

2: WB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations			↑			↑
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	0	245	365	0	0	340
Peak Hour Factor	0.84	0.86	0.84	0.92	0.92	0.91
Hourly flow rate (vph)	0	285	435	0	0	374
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh						
Upstream signal (ft)		568				
pX, platoon unblocked	0.86	0.86		0.86		
vC, conflicting volume	808	435		435		
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	777	342		342		
tC, single (s)	6.4	6.2		4.1		
tC, 2 stage (s)						
tF (s)	3.5	3.3		2.2		
p0 queue free %	100	53		100		
cM capacity (veh/h)	312	606		1056		
Direction, Lane #	WB 1	NB 1	SB 1			
Volume Total	285	435	374			
Volume Left	0	0	0			
Volume Right	285	0	0			
cSH	606	1700	1700			
Volume to Capacity	0.47	0.26	0.22			
Queue Length 95th (ft)	63	0	0			
Control Delay (s)	16.1	0.0	0.0			
Lane LOS	C					
Approach Delay (s)	16.1	0.0	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay		4.2				
Intersection Capacity Utilization		41.0%	ICU Level of Service		A	
Analysis Period (min)		15				

HCM Signalized Intersection Capacity Analysis

3: EB I-96 off-ramp & M-100 (Wright Rd)

07/10/2006

Movement	EBL	EBT	EBC	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0				4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00			1.00				1.00	1.00	1.00	1.00	1.00
Fr _t	1.00			0.85				1.00	0.85	1.00	1.00	1.00
Flt Protected	0.95			1.00				1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805			1599				1863	1538	1612	1827	
Flt Permitted	0.95			1.00				1.00	1.00	0.47	1.00	
Satd. Flow (perm)	1805			1599				1863	1538	795	1827	
Volume (vph)	25	0	140	0	0	0	0	340	160	100	240	0
Peak-hour factor, PHF	0.55	0.92	0.79	0.92	0.92	0.92	0.92	0.95	0.85	0.72	0.84	0.92
Adj. Flow (vph)	45	0	177	0	0	0	0	358	188	139	286	0
RTOR Reduction (vph)	0	0	138	0	0	0	0	0	113	0	0	0
Lane Group Flow (vph)	45	0	39	0	0	0	0	358	75	139	286	0
Heavy Vehicles (%)	0%	0%	1%	0%	0%	0%	0%	2%	5%	12%	4%	0%
Turn Type	Prot		custom							Perm	pm+pt	
Protected Phases	2		2					8		7	4	7
Permitted Phases									8	4	7	
Actuated Green, G (s)	9.2		9.2					18.2	18.2	29.2	29.2	
Effective Green, g (s)	11.0		11.0					20.0	20.0	31.0	31.0	
Actuated g/C Ratio	0.22		0.22					0.40	0.40	0.62	0.62	
Clearance Time (s)	5.8		5.8					5.8	5.8	5.8	5.8	
Lane Grp Cap (vph)	397		352					745	615	607	1133	
v/s Ratio Prot	c0.02		0.02					c0.19		0.03	c0.16	
v/s Ratio Perm									0.05	0.11		
v/c Ratio	0.11		0.11					0.48	0.12	0.23	0.25	
Uniform Delay, d1	15.6		15.6					11.1	9.5	5.9	4.3	
Progression Factor	1.00		1.00					0.79	0.90	0.96	0.97	
Incremental Delay, d2	0.6		0.6					1.9	0.3	0.9	0.5	
Delay (s)	16.2		16.2					10.6	8.9	6.6	4.7	
Level of Service	B		B					B	A	A	A	
Approach Delay (s)		16.2			0.0			10.0			5.3	
Approach LOS		B			A			B			A	
Intersection Summary												
HCM Average Control Delay		9.5			HCM Level of Service				A			
HCM Volume to Capacity ratio		0.32										
Actuated Cycle Length (s)		50.0			Sum of lost time (s)				8.0			
Intersection Capacity Utilization		41.0%			ICU Level of Service				A			
Analysis Period (min)		15										
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

4: Grand River Ave & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↑ ↗	↑ ↘		↑ ↗	↑ ↘		↑ ↗	↑ ↘		↑ ↗	↑ ↘	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Fr _t	1.00	0.95		1.00	0.93		1.00	0.96		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1444	1734		1770	1724		1805	1812		1671	1827	
Flt Permitted	0.40	1.00		0.69	1.00		0.52	1.00		0.34	1.00	
Satd. Flow (perm)	615	1734		1281	1724		990	1812		591	1827	
Volume (vph)	20	45	30	160	160	150	80	310	115	70	255	30
Peak-hour factor, PHF	0.60	0.65	0.79	0.74	0.74	0.90	0.70	0.81	0.84	0.74	0.92	0.64
Adj. Flow (vph)	33	69	38	216	216	167	114	383	137	95	277	47
RTOR Reduction (vph)	0	24	0	0	55	0	0	26	0	0	12	0
Lane Group Flow (vph)	33	83	0	216	328	0	114	494	0	95	312	0
Heavy Vehicles (%)	25%	3%	5%	2%	3%	3%	0%	1%	0%	8%	2%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	16.7	16.7		16.7	16.7		21.7	21.7		21.7	21.7	
Effective Green, g (s)	18.5	18.5		18.5	18.5		23.5	23.5		23.5	23.5	
Actuated g/C Ratio	0.37	0.37		0.37	0.37		0.47	0.47		0.47	0.47	
Clearance Time (s)	5.8	5.8		5.8	5.8		5.8	5.8		5.8	5.8	
Lane Grp Cap (vph)	228	642		474	638		465	852		278	859	
v/s Ratio Prot	0.05			c0.19			c0.27			0.17		
v/s Ratio Perm	0.05			0.17			0.12			0.16		
v/c Ratio	0.14	0.13		0.46	0.51		0.25	0.58		0.34	0.36	
Uniform Delay, d1	10.5	10.4		11.9	12.2		7.9	9.7		8.4	8.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		0.79	0.78	
Incremental Delay, d2	1.3	0.4		3.1	2.9		1.3	2.9		3.2	1.2	
Delay (s)	11.8	10.8		15.1	15.2		9.2	12.5		9.8	7.7	
Level of Service	B	B		B	B		A	B		A	A	
Approach Delay (s)		11.1			15.1			11.9			8.2	
Approach LOS		B			B			B			A	
Intersection Summary												
HCM Average Control Delay	12.1			HCM Level of Service			B					
HCM Volume to Capacity ratio	0.55											
Actuated Cycle Length (s)	50.0			Sum of lost time (s)			8.0					
Intersection Capacity Utilization	54.8%			ICU Level of Service			A					
Analysis Period (min)	15											
c Critical Lane Group												

MODERN ROUNDABOUT ALTERNATIVE

I-96_Wright Rd-North Ramps-2030 peak hours.txt

23:6:06

I-96/WRIGHT RD NORTH ROUNDABOUT

4

E (m)	4.12	4.12	4.12	4.12	TIME PERIOD min	90
L' (m)	8.00	8.00	8.00	8.00	TIME SLICE min	15
V (m)	3.65	3.65	3.65	3.65	RESULTS PERIOD min	15 75
RAD (m)	24.38	24.38	24.38	24.38	TIME COST \$/hr	15.00
PHI (d)	30.00	30.00	30.00	30.00	FLOW PERIOD min	15 75
DIA (m)	36.58	36.58	36.58	36.58	FLOW TYPE pcu/veh	VEH
GRAD SEP	0	0	0	0	FLOW PEAK am/op/pm	AM

LEG NAME	PCU	FLOWS (1st exit 2nd etc...u)	FLOF	CL	FLOW RATIO	FLOW TIME
WRIGHT NO	1.05	20 425 0 0	1.00	50	0.75 1.125 0.75	15 45 75
I-96 ON	1.05	0 0 0 0	1.00	50	0.75 1.125 0.75	15 45 75
WRIGHT SO	1.05	0 60 145 0	1.00	50	0.75 1.125 0.75	15 45 75
I-96 OFF	1.05	40 1 115 0	1.00	50	0.75 1.125 0.75	15 45 75

FLOW	veh	445	0	205	156	MODE 2	
CAPACITY	veh	1032	876	1178	1063		AVDEL s 5.0
AVE DELAY	mins	0.10	0.00	0.06	0.06		L O S A
MAX DELAY	mins	0.14	0.00	0.08	0.08		VEH HRS 1.1
AVE QUEUE	veh	1	0	0	0		COST \$ 16.8
MAX QUEUE	veh	1	0	0	0		

23:6:06

I-96/WRIGHT RD NORTH ROUNDABOUT

3

E (m)	4.12	4.12	4.12	4.12	TIME PERIOD min	90
L' (m)	8.00	8.00	8.00	8.00	TIME SLICE min	15
V (m)	3.65	3.65	3.65	3.65	RESULTS PERIOD min	15 75
RAD (m)	24.38	24.38	24.38	24.38	TIME COST \$/hr	15.00
PHI (d)	30.00	30.00	30.00	30.00	FLOW PERIOD min	15 75
DIA (m)	36.58	36.58	36.58	36.58	FLOW TYPE pcu/veh	VEH
GRAD SEP	0	0	0	0	FLOW PEAK am/op/pm	PM

LEG NAME	PCU	FLOWS (1st exit 2nd etc...u)	FLOF	CL	FLOW RATIO	FLOW TIME
WRIGHT NO	1.05	20 175 0 0	1.00	95	0.75 1.125 0.75	15 45 75
I-96 ON	1.05	0 0 0 0	1.00	95	0.75 1.125 0.75	15 45 75
WRIGHT SO	1.05	0 175 180 0	1.00	95	0.75 1.125 0.75	15 45 75
I-96 OFF	1.05	245 1 165 0	1.00	95	0.75 1.125 0.75	15 45 75

FLOW	veh	195	0	355	411	MODE 2	
CAPACITY	veh	770	774	963	765		AVDEL s 7.7
AVE DELAY	mins	0.10	0.00	0.10	0.17		L O S A
MAX DELAY	mins	0.14	0.00	0.13	0.25		VEH HRS 2.1
AVE QUEUE	veh	0	0	1	1		COST \$ 31.0
MAX QUEUE	veh	0	0	1	2		

I-96_Wright Rd-South Ramps-2030 peak hours.txt

23:6:06

I-96/WRIGHT RD SOUTH ROUNDABOUT

9

E (m)	4.12	4.12	4.12	4.12		TIME PERIOD	min	90
L' (m)	8.00	8.00	8.00	8.00		TIME SLICE	min	15
V (m)	3.65	3.65	3.65	3.65		RESULTS PERIOD	min	15 75
RAD (m)	24.38	24.38	24.38	24.38		TIME COST	\$/hr	15.00
PHI (d)	30.00	30.00	30.00	30.00		FLOW PERIOD	min	15 75
DIA (m)	36.58	36.58	36.58	36.58		FLOW TYPE	pcu/veh	VEH
GRAD SEP	0	0	0	0		FLOW PEAK	am/op/pm	AM

LEG NAME	PCU	FLOWS	(1st exit	2nd etc...)	U	FLOF	CL	FLOW RATIO	FLOW TIME
WRIGHT NO	1.05	0	275	265	0	1.00	95	0.75 1.125 0.75	15 45 75
I-96 OFF	1.05	155	1	20	0	1.00	95	0.75 1.125 0.75	15 45 75
WRIGHT SO	1.05	200	200	0	0	1.00	95	0.75 1.125 0.75	15 45 75
I-96 ON	1.05	0	0	0	0	1.00	95	0.75 1.125 0.75	15 45 75

FLOW	veh	540	176	400	0	MODE	2		
CAPACITY	veh	963	662	804	841			AVDEL	s 8.4
AVE DELAY	mins	0.14	0.12	0.15	0.00			L O S	A
MAX DELAY	mins	0.20	0.17	0.21	0.00			VEH HRS	2.6
AVE QUEUE	veh	1	0	1	0			COST \$	39.0
MAX QUEUE	veh	2	0	1	0				

23:6:06

I-96/WRIGHT RD SOUTH ROUNDABOUT

8

E (m)	4.12	4.12	4.12	4.12		TIME PERIOD	min	90
L' (m)	8.00	8.00	8.00	8.00		TIME SLICE	min	15
V (m)	3.65	3.65	3.65	3.65		RESULTS PERIOD	min	15 75
RAD (m)	24.38	24.38	24.38	24.38		TIME COST	\$/hr	15.00
PHI (d)	30.00	30.00	30.00	30.00		FLOW PERIOD	min	15 75
DIA (m)	36.58	36.58	36.58	36.58		FLOW TYPE	pcu/veh	VEH
GRAD SEP	0	0	0	0		FLOW PEAK	am/op/pm	PM

LEG NAME	PCU	FLOWS	(1st exit	2nd etc...)	U	FLOF	CL	FLOW RATIO	FLOW TIME
WRIGHT NO	1.05	0	240	100	0	1.00	95	0.75 1.125 0.75	15 45 75
I-96 OFF	1.05	140	1	25	0	1.00	95	0.75 1.125 0.75	15 45 75
WRIGHT SO	1.05	160	340	0	0	1.00	95	0.75 1.125 0.75	15 45 75
I-96 ON	1.05	0	0	0	0	1.00	95	0.75 1.125 0.75	15 45 75

FLOW	veh	340	166	500	0	MODE	2		
CAPACITY	veh	963	774	893	760			AVDEL	s 7.4
AVE DELAY	mins	0.09	0.10	0.15	0.00			L O S	A
MAX DELAY	mins	0.12	0.13	0.21	0.00			VEH HRS	2.1
AVE QUEUE	veh	1	0	1	0			COST \$	30.9
MAX QUEUE	veh	1	0	2	0				

RELOCATED EASTBOUND RAMPS ALTERNATIVE

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0		4.0	4.0	4.0		4.0	4.0
Lane Util. Factor					1.00		1.00	1.00	1.00		1.00	1.00
Fr _t					1.00		0.85	1.00	1.00		1.00	0.85
Flt Protected					0.95		1.00	0.95	1.00		1.00	1.00
Satd. Flow (prot)					1597		1615	1641	1810		1863	1615
Flt Permitted					0.95		1.00	0.35	1.00		1.00	1.00
Satd. Flow (perm)					1597		1615	597	1810		1863	1615
Volume (vph)	0	0	0	115	0	40	145	60	0	0	425	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.92	0.69	0.79	0.63	0.92	0.92	0.88	0.42
Adj. Flow (vph)	0	0	0	158	0	58	184	95	0	0	483	48
RTOR Reduction (vph)	0	0	0	0	0	45	0	0	0	0	0	29
Lane Group Flow (vph)	0	0	0	158	0	13	184	95	0	0	483	19
Heavy Vehicles (%)	2%	2%	2%	13%	0%	0%	10%	5%	0%	2%	2%	0%
Turn Type				Prot		custom	custom					Perm
Protected Phases				6		6	3	3.8				4
Permitted Phases							8					4
Actuated Green, G (s)				9.2		9.2	30.2	30.2			18.2	18.2
Effective Green, g (s)				11.0		11.0	31.0	31.0			20.0	20.0
Actuated g/C Ratio				0.22		0.22	0.62	0.62			0.40	0.40
Clearance Time (s)				5.8		5.8	5.8				5.8	5.8
Lane Grp Cap (vph)				351		355	516	1122			745	646
v/s Ratio Prot				c0.10		0.01	c0.05	0.05			c0.26	
v/s Ratio Perm							0.17					0.01
v/c Ratio				0.45		0.04	0.36	0.08			0.65	0.03
Uniform Delay, d1				16.9		15.3	8.7	3.8			12.2	9.1
Progression Factor				1.00		1.00	0.87	0.99			1.00	1.00
Incremental Delay, d2				4.1		0.2	1.9	0.1			4.3	0.1
Delay (s)				21.0		15.5	9.4	3.9			16.5	9.2
Level of Service				C		B	A	A			B	A
Approach Delay (s)	0.0				19.5			7.6			15.8	
Approach LOS	A				B			A			B	
Intersection Summary												
HCM Average Control Delay	14.4				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.49											
Actuated Cycle Length (s)	50.0				Sum of lost time (s)			8.0				
Intersection Capacity Utilization	46.8%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

07/10/2006

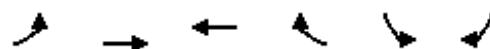


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control												
Volume (vph)												
Volume Total (vph)	10	130	60	250	40	60	30	100	305	350	200	5
Peak Hour Factor	0.70	0.98	0.58	0.73	0.79	0.79	0.63	0.77	0.77	0.73	0.78	0.25
Hourly flow rate (vph)	14	133	103	342	51	76	48	130	396	479	256	20
Direction, Lane #												
Volume Left (vph)	250	469	48	526	479	276						
Volume Right (vph)	14	342	48	0	479	0						
Hadj (s)	-0.16	0.22	0.58	-0.45	0.70	0.03						
Departure Headway (s)	9.3	8.8	9.5	8.5	9.6	8.9						
Degree Utilization, x	0.65	1.15	0.13	1.24	1.28	0.69						
Capacity (veh/h)	378	398	372	430	381	395						
Control Delay (s)	27.8	119.3	12.7	152.8	172.0	28.2						
Approach Delay (s)	27.8	119.3	141.2		119.4							
Approach LOS	D	F	F		F							
Intersection Summary												
Delay					114.3							
HCM Level of Service					F							
Intersection Capacity Utilization				87.4%			ICU Level of Service			E		
Analysis Period (min)				15								

HCM Unsignalized Intersection Capacity Analysis

8: Grand River Ave & EB Ramps

07/10/2006



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↑	↑	↑		↑	↑
Sign Control	Free	Free		Stop		
Grade	0%	0%		0%		
Volume (veh/h)	410	375	220	55	45	130
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	446	408	239	60	49	141
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None		
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	299			1568	269	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	299			1568	269	
tC, single (s)	4.1			6.4	6.2	
tC, 2 stage (s)						
tF (s)	2.2			3.5	3.3	
p0 queue free %	65			38	82	
cM capacity (veh/h)	1262			79	770	
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	446	408	299	49	141	
Volume Left	446	0	0	49	0	
Volume Right	0	0	60	0	141	
cSH	1262	1700	1700	79	770	
Volume to Capacity	0.35	0.24	0.18	0.62	0.18	
Queue Length 95th (ft)	40	0	0	70	17	
Control Delay (s)	9.4	0.0	0.0	106.5	10.7	
Lane LOS	A			F	B	
Approach Delay (s)	4.9		0.0	35.3		
Approach LOS				E		
Intersection Summary						
Average Delay	8.1					
Intersection Capacity Utilization	51.0%	ICU Level of Service	A			
Analysis Period (min)	15					

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0		4.0	4.0	4.0		4.0	4.0
Lane Util. Factor					1.00		1.00	1.00	1.00		1.00	1.00
Fr _t					1.00		0.85	1.00	1.00		1.00	0.85
Flt Protected					0.95		1.00	0.95	1.00		1.00	1.00
Satd. Flow (prot)					1597		1615	1641	1810		1863	1615
Flt Permitted					0.95		1.00	0.63	1.00		1.00	1.00
Satd. Flow (perm)					1597		1615	1088	1810		1863	1615
Volume (vph)	0	0	0	165	0	245	180	175	0	0	175	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.92	0.69	0.79	0.63	0.92	0.92	0.88	0.42
Adj. Flow (vph)	0	0	0	226	0	355	228	278	0	0	199	48
RTOR Reduction (vph)	0	0	0	0	0	256	0	0	0	0	0	32
Lane Group Flow (vph)	0	0	0	226	0	99	228	278	0	0	199	16
Heavy Vehicles (%)	2%	2%	2%	13%	0%	0%	10%	5%	0%	2%	2%	0%
Turn Type				Prot		custom	custom					Perm
Protected Phases				6		6	3	3.8				4
Permitted Phases							8					4
Actuated Green, G (s)				12.2		12.2	27.2	27.2			15.2	15.2
Effective Green, g (s)				14.0		14.0	28.0	28.0			17.0	17.0
Actuated g/C Ratio				0.28		0.28	0.56	0.56			0.34	0.34
Clearance Time (s)				5.8		5.8	5.8				5.8	5.8
Lane Grp Cap (vph)				447		452	687	1014			633	549
v/s Ratio Prot				c0.14		0.06	c0.05	0.15			0.11	
v/s Ratio Perm							c0.14				0.01	
v/c Ratio				0.51		0.22	0.33	0.27			0.31	0.03
Uniform Delay, d1				15.1		13.8	6.2	5.7			12.2	11.0
Progression Factor				1.00		1.00	0.96	0.98			1.00	1.00
Incremental Delay, d2				4.0		1.1	1.3	0.7			1.3	0.1
Delay (s)				19.1		14.9	7.2	6.2			13.5	11.1
Level of Service				B		B	A	A			B	B
Approach Delay (s)	0.0				16.6			6.7			13.0	
Approach LOS	A				B			A			B	
Intersection Summary												
HCM Average Control Delay	12.2				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.38											
Actuated Cycle Length (s)	50.0				Sum of lost time (s)			8.0				
Intersection Capacity Utilization	41.6%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

07/10/2006

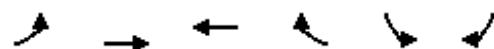


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control												
Volume (vph)												
Peak Hour Factor												
Hourly flow rate (vph)												
Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2						
Volume Total (vph)	124	729	127	552	192	227						
Volume Left (vph)	21	349	127	0	192	0						
Volume Right (vph)	52	158	0	286	0	60						
Hadj (s)	-0.05	0.16	0.58	-0.26	0.70	-0.12						
Departure Headway (s)	8.7	7.4	8.4	7.6	8.9	8.1						
Degree Utilization, x	0.30	1.50	0.30	1.16	0.48	0.51						
Capacity (veh/h)	400	479	423	481	389	429						
Control Delay (s)	15.4	256.3	13.7	117.8	18.6	18.0						
Approach Delay (s)	15.4	256.3	98.3		18.3							
Approach LOS	C	F	F		C							
Intersection Summary												
Delay	134.9											
HCM Level of Service	F											
Intersection Capacity Utilization	79.6%											
Analysis Period (min)	15											

HCM Unsignalized Intersection Capacity Analysis

8: Grand River Ave & EB Ramps

07/10/2006



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↑	↑	↑		↑	↑
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	210	200	420	50	30	135
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	228	217	457	54	33	147
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	511			1158	484	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	511			1158	484	
tC, single (s)	4.1			6.4	6.2	
tC, 2 stage (s)						
tF (s)	2.2			3.5	3.3	
p0 queue free %	78			81	75	
cM capacity (veh/h)	1054			170	583	
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	228	217	511	33	147	
Volume Left	228	0	0	33	0	
Volume Right	0	0	54	0	147	
cSH	1054	1700	1700	170	583	
Volume to Capacity	0.22	0.13	0.30	0.19	0.25	
Queue Length 95th (ft)	21	0	0	17	25	
Control Delay (s)	9.4	0.0	0.0	31.2	13.2	
Lane LOS	A			D	B	
Approach Delay (s)	4.8		0.0	16.5		
Approach LOS				C		
Intersection Summary						
Average Delay	4.5					
Intersection Capacity Utilization	50.1%	ICU Level of Service	A			
Analysis Period (min)	15					

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0		4.0	4.0	4.0		4.0	4.0
Lane Util. Factor					1.00		1.00	1.00	1.00		1.00	1.00
Fr _t					1.00		0.85	1.00	1.00		1.00	0.85
Flt Protected					0.95		1.00	0.95	1.00		1.00	1.00
Satd. Flow (prot)					1597		1615	1641	1810		1863	1615
Flt Permitted					0.95		1.00	0.33	1.00		1.00	1.00
Satd. Flow (perm)					1597		1615	568	1810		1863	1615
Volume (vph)	0	0	0	115	0	40	145	60	0	0	425	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.92	0.69	0.79	0.63	0.92	0.92	0.88	0.42
Adj. Flow (vph)	0	0	0	158	0	58	184	95	0	0	483	48
RTOR Reduction (vph)	0	0	0	0	0	44	0	0	0	0	0	27
Lane Group Flow (vph)	0	0	0	158	0	14	184	95	0	0	483	21
Heavy Vehicles (%)	2%	2%	2%	13%	0%	0%	10%	5%	0%	2%	2%	0%
Turn Type				Prot		custom	custom					Perm
Protected Phases				6		6	3	3.8				4
Permitted Phases							8					4
Actuated Green, G (s)				20.2		20.2	59.2	59.2			38.2	38.2
Effective Green, g (s)				22.0		22.0	60.0	60.0			40.0	40.0
Actuated g/C Ratio				0.24		0.24	0.67	0.67			0.44	0.44
Clearance Time (s)				5.8		5.8	5.8				5.8	5.8
Lane Grp Cap (vph)				390		395	569	1207			828	718
v/s Ratio Prot				c0.10		0.01	c0.06	0.05			c0.26	
v/s Ratio Perm							0.16					0.01
v/c Ratio				0.41		0.04	0.32	0.08			0.58	0.03
Uniform Delay, d1				28.5		25.9	14.0	5.3			18.8	14.1
Progression Factor				1.00		1.00	0.81	1.31			1.00	1.00
Incremental Delay, d2				3.1		0.2	1.4	0.1			3.0	0.1
Delay (s)				31.6		26.1	12.8	7.0			21.7	14.2
Level of Service				C		C	B	A			C	B
Approach Delay (s)	0.0				30.1			10.8			21.1	
Approach LOS	A				C			B			C	
Intersection Summary												
HCM Average Control Delay	20.2				HCM Level of Service			C				
HCM Volume to Capacity ratio	0.46											
Actuated Cycle Length (s)	90.0				Sum of lost time (s)			8.0				
Intersection Capacity Utilization	46.8%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

07/10/2006

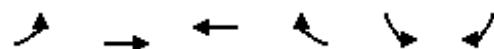


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↑	↓		↑	↓		↑	↓		↑	↓	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Fr _t	1.00	0.93		1.00	0.91		1.00	0.89		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1262	1733		1671	1501		1719	1613		1612	1796	
Flt Permitted	0.63	1.00		0.41	1.00		0.46	1.00		0.14	1.00	
Satd. Flow (perm)	836	1733		726	1501		840	1613		246	1796	
Volume (vph)	10	130	60	250	40	60	30	100	305	350	200	5
Peak-hour factor, PHF	0.70	0.98	0.58	0.73	0.79	0.79	0.63	0.77	0.77	0.73	0.78	0.25
Adj. Flow (vph)	14	133	103	342	51	76	48	130	396	479	256	20
RTOR Reduction (vph)	0	31	0	0	58	0	0	122	0	0	3	0
Lane Group Flow (vph)	14	205	0	342	69	0	48	404	0	479	273	0
Heavy Vehicles (%)	43%	2%	3%	8%	14%	16%	5%	9%	3%	12%	5%	0%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	21.0	16.0		27.8	19.4		25.8	21.8		48.2	38.4	
Effective Green, g (s)	24.6	17.8		31.4	21.2		29.4	23.6		50.0	40.2	
Actuated g/C Ratio	0.27	0.20		0.35	0.24		0.33	0.26		0.56	0.45	
Clearance Time (s)	5.8	5.8		5.8	5.8		5.8	5.8		5.8	5.8	
Lane Grp Cap (vph)	261	343		360	354		331	423		477	802	
v/s Ratio Prot	0.00	0.12		c0.11	0.05		0.01	0.25		c0.25	0.15	
v/s Ratio Perm	0.01			c0.22			0.04			c0.31		
v/c Ratio	0.05	0.60		0.95	0.19		0.15	0.96		1.00	0.34	
Uniform Delay, d ₁	25.0	32.8		30.8	27.6		25.0	32.7		30.5	16.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		0.66	0.53	
Incremental Delay, d ₂	0.4	7.5		36.3	1.2		0.9	34.0		40.2	1.0	
Delay (s)	25.4	40.3		67.2	28.8		26.0	66.6		60.2	9.6	
Level of Service	C	D		E	C		C	E		E	A	
Approach Delay (s)		39.5			56.8			63.2			41.7	
Approach LOS		D			E			E			D	
Intersection Summary												
HCM Average Control Delay		50.9					HCM Level of Service			D		
HCM Volume to Capacity ratio		0.99										
Actuated Cycle Length (s)		90.0					Sum of lost time (s)			12.0		
Intersection Capacity Utilization		81.1%					ICU Level of Service			D		
Analysis Period (min)		15										
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis

8: Grand River Ave & EB Ramps

07/10/2006



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↑	↑	↑		↑	↑
Sign Control	Free	Free		Stop		
Grade	0%	0%		0%		
Volume (veh/h)	410	375	220	55	45	130
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	446	408	239	60	49	141
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None		
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	299			1568	269	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	299			1568	269	
tC, single (s)	4.1			6.4	6.2	
tC, 2 stage (s)						
tF (s)	2.2			3.5	3.3	
p0 queue free %	65			38	82	
cM capacity (veh/h)	1262			79	770	
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	446	408	299	49	141	
Volume Left	446	0	0	49	0	
Volume Right	0	0	60	0	141	
cSH	1262	1700	1700	79	770	
Volume to Capacity	0.35	0.24	0.18	0.62	0.18	
Queue Length 95th (ft)	40	0	0	70	17	
Control Delay (s)	9.4	0.0	0.0	106.5	10.7	
Lane LOS	A			F	B	
Approach Delay (s)	4.9		0.0	35.3		
Approach LOS				E		
Intersection Summary						
Average Delay	8.1					
Intersection Capacity Utilization	51.0%	ICU Level of Service	A			
Analysis Period (min)	15					

HCM Signalized Intersection Capacity Analysis

1: WB I-96 on-ramp & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)					4.0		4.0	4.0	4.0		4.0	4.0
Lane Util. Factor					1.00		1.00	1.00	1.00		1.00	1.00
Fr _t					1.00		0.85	1.00	1.00		1.00	0.85
Flt Protected					0.95		1.00	0.95	1.00		1.00	1.00
Satd. Flow (prot)					1597		1615	1641	1810		1863	1615
Flt Permitted					0.95		1.00	0.55	1.00		1.00	1.00
Satd. Flow (perm)					1597		1615	958	1810		1863	1615
Volume (vph)	0	0	0	165	0	245	180	175	0	0	175	20
Peak-hour factor, PHF	0.92	0.92	0.92	0.73	0.92	0.69	0.79	0.63	0.92	0.92	0.88	0.42
Adj. Flow (vph)	0	0	0	226	0	355	228	278	0	0	199	48
RTOR Reduction (vph)	0	0	0	0	0	235	0	0	0	0	0	35
Lane Group Flow (vph)	0	0	0	226	0	120	228	278	0	0	199	13
Heavy Vehicles (%)	2%	2%	2%	13%	0%	0%	10%	5%	0%	2%	2%	0%
Turn Type				Prot		custom	custom					Perm
Protected Phases				6		6	3	3.8				4
Permitted Phases							8					4
Actuated Green, G (s)				25.2		25.2	44.2	44.2			20.2	20.2
Effective Green, g (s)				27.0		27.0	45.0	45.0			22.0	22.0
Actuated g/C Ratio				0.34		0.34	0.56	0.56			0.28	0.28
Clearance Time (s)				5.8		5.8	5.8				5.8	5.8
Lane Grp Cap (vph)				539		545	701	1018			512	444
v/s Ratio Prot				c0.14		0.07	c0.08	0.15			c0.11	
v/s Ratio Perm							0.11					0.01
v/c Ratio				0.42		0.22	0.33	0.27			0.39	0.03
Uniform Delay, d1				20.5		19.0	11.5	9.0			23.5	21.2
Progression Factor				1.00		1.00	0.64	0.76			1.00	1.00
Incremental Delay, d2				2.4		0.9	0.9	0.5			2.2	0.1
Delay (s)				22.8		19.9	8.3	7.4			25.8	21.3
Level of Service				C		B	A	A			C	C
Approach Delay (s)	0.0				21.0			7.8			24.9	
Approach LOS	A				C			A			C	
Intersection Summary												
HCM Average Control Delay	16.7				HCM Level of Service			B				
HCM Volume to Capacity ratio	0.37											
Actuated Cycle Length (s)	80.0				Sum of lost time (s)			8.0				
Intersection Capacity Utilization	41.6%				ICU Level of Service			A				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

3: Grand River Ave & M-100 (Wright Rd)

07/10/2006



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↑	↓		↑	↓		↑	↓		↑	↓	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Fr _t	1.00	0.92		1.00	0.94		1.00	0.92		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1262	1713		1671	1551		1719	1655		1612	1760	
Flt Permitted	0.22	1.00		0.69	1.00		0.56	1.00		0.19	1.00	
Satd. Flow (perm)	288	1713		1215	1551		1005	1655		331	1760	
Volume (vph)	15	50	30	255	175	125	80	205	220	140	130	15
Peak-hour factor, PHF	0.70	0.98	0.58	0.73	0.79	0.79	0.63	0.77	0.77	0.73	0.78	0.25
Adj. Flow (vph)	21	51	52	349	222	158	127	266	286	192	167	60
RTOR Reduction (vph)	0	39	0	0	32	0	0	49	0	0	16	0
Lane Group Flow (vph)	21	64	0	349	348	0	127	503	0	192	211	0
Heavy Vehicles (%)	43%	2%	3%	8%	14%	16%	5%	9%	3%	12%	5%	0%
Turn Type	pm+pt			pm+pt			pm+pt			pm+pt		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	22.0	18.0		24.4	19.2		32.4	28.4		34.8	29.6	
Effective Green, g (s)	25.6	19.8		28.0	21.0		36.0	30.2		38.4	31.4	
Actuated g/C Ratio	0.32	0.25		0.35	0.26		0.45	0.38		0.48	0.39	
Clearance Time (s)	5.8	5.8		5.8	5.8		5.8	5.8		5.8	5.8	
Lane Grp Cap (vph)	163	424		465	407		504	625		271	691	
v/s Ratio Prot	0.01	0.04		c0.07	c0.22		0.02	c0.30		c0.06	0.12	
v/s Ratio Perm	0.03			0.20			0.10			0.28		
v/c Ratio	0.13	0.15		0.75	0.86		0.25	0.81		0.71	0.30	
Uniform Delay, d1	28.2	23.5		23.7	28.1		15.6	22.3		27.6	16.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		0.84	0.43	
Incremental Delay, d2	1.6	0.8		10.6	20.0		1.2	10.6		13.6	1.1	
Delay (s)	29.8	24.3		34.4	48.1		16.8	32.9		36.9	8.2	
Level of Service	C	C		C	D		B	C		D	A	
Approach Delay (s)		25.2			41.5			29.9			21.4	
Approach LOS		C			D			C			C	

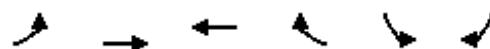
Intersection Summary

HCM Average Control Delay	32.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis

8: Grand River Ave & EB Ramps

07/10/2006



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↑	↑	↑		↑	↑
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	210	200	420	50	30	135
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	228	217	457	54	33	147
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	511			1158	484	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	511			1158	484	
tC, single (s)	4.1			6.4	6.2	
tC, 2 stage (s)						
tF (s)	2.2			3.5	3.3	
p0 queue free %	78			81	75	
cM capacity (veh/h)	1054			170	583	
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	228	217	511	33	147	
Volume Left	228	0	0	33	0	
Volume Right	0	0	54	0	147	
cSH	1054	1700	1700	170	583	
Volume to Capacity	0.22	0.13	0.30	0.19	0.25	
Queue Length 95th (ft)	21	0	0	17	25	
Control Delay (s)	9.4	0.0	0.0	31.2	13.2	
Lane LOS	A			D	B	
Approach Delay (s)	4.8		0.0	16.5		
Approach LOS				C		
Intersection Summary						
Average Delay	4.5					
Intersection Capacity Utilization	50.1%	ICU Level of Service	A			
Analysis Period (min)	15					

Appendix D

Detailed Construction Cost Breakdowns

I-96/M-100 Interchange Study
Diamond Interchange Alternative Variation #1

<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Cost per Unit</u>	<u>Item Cost</u>
Mobilization	1	LS	\$ 350,000 /LS	\$ 350,000
Pavement Removal	26,100	sq yds	\$ 6 /sq yds	\$ 157,000
Earthwork	157,600	cu yds	\$ 9 /cu yds	\$ 1,419,000
Subbase	12,300	cu yds	\$ 10 /cu yds	\$ 123,000
Open Graded Drainage Course, 4"	31,700	sq yds	\$ 6 /sq yds	\$ 191,000
Geotextile Separator	31,700	sq yds	\$ 3 /sq yds	\$ 96,000
Concrete Pavement, Reinforced, 11'	20,600	sq yds	\$ 50 /sq yds	\$ 1,030,000
Shoulder, Nonreinforced Concrete	11,100	sq yds	\$ 25 /sq yds	\$ 278,000
Maintenance of Traffic	1	LS	\$ 330,000 /LS	\$ 330,000
Signals	-	LS	\$ 30,000 /LS	\$ -
Miscellaneous	15%		\$ 540,000	\$ 540,000
Estimated Inflation (3.0%/year)	16%		\$ 580,000	\$ 580,000
Right Of Way Costs	1 LS	x	\$ 270,000 /LS	\$ 270,000
Total Road Construction Estimate				\$ 5,364,000
 Bridge Work				
<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Cost per Unit</u>	<u>Item Cost</u>
Bridge Removal	6,700	Sft	\$ 30 /Sft	\$ 201,000
Bridge Construction	15,340	Sft	\$ 145 /Sft	\$ 2,225,000
Miscellaneous	15%		\$ 360,000	\$ 360,000
Estimated Inflation (3.0%/year)	16%		\$ 390,000	\$ 390,000
Total Bridge Construction Estimate				\$ 3,176,000
 TOTAL CONSTRUCTION ESTIMATE =				\$ 8,540,000

Estimate is in 2011 dollars
 Provided by URS Corporation

**I-96/M-100 Interchange Study
Diamond Interchange Alternative Variation #2**

<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Cost per Unit</u>	<u>Item Cost</u>
Mobilization	1	LS	\$ 300,000 /LS	\$ 300,000
Pavement Removal	26,100	sq yds	\$ 6 /sq yds	\$ 157,000
Earthwork	81,600	cu yds	\$ 9 /cu yds	\$ 735,000
Subbase	11,700	cu yds	\$ 10 /cu yds	\$ 117,000
Open Graded Drainage Course, 4"	30,200	sq yds	\$ 6 /sq yds	\$ 182,000
Geotextile Separator	30,200	sq yds	\$ 3 /sq yds	\$ 91,000
Concrete Pavement, Reinforced, 11'	19,700	sq yds	\$ 50 /sq yds	\$ 985,000
Shoulder, Nonreinforced Concrete	10,500	sq yds	\$ 25 /sq yds	\$ 263,000
Maintenance of Traffic	1	LS	\$ 250,000 /LS	\$ 250,000
Signals	-	LS	\$ 30,000 /LS	\$ -
Miscellaneous	15%		\$ 420,000	\$ 420,000
Estimated Inflation (3.0%/year)	16%		\$ 440,000	\$ 440,000
Right Of Way Costs	0	LS	\$ - /LS	\$ -
Total Road Construction Estimate				\$ 3,940,000
 Bridge Work				
<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Cost per Unit</u>	<u>Item Cost</u>
Bridge Removal	6,700	Sft	\$ 30 /Sft	\$ 201,000
Bridge Construction	15,340	Sft	\$ 145 /Sft	\$ 2,225,000
Miscellaneous	15%		\$ 360,000	\$ 360,000
Estimated Inflation (3.0%/year)	16%		\$ 390,000	\$ 390,000
Total Bridge Construction Estimate				\$ 3,176,000
 TOTAL CONSTRUCTION ESTIMATE =				\$ 7,116,000

Estimate is in 2011 dollars
Provided by URS Corporation

**I-96/M-100 Interchange Study
Partial Cloverleaf Concept**

<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Cost per Unit</u>	<u>Item Cost</u>
Mobilization	1	LS	\$ 360,000 /LS	\$ 360,000
Pavement Removal	26,200	sq yds	\$ 6 /sq yds	\$ 158,000
Earthwork	123,300	cu yds	\$ 9 /cu yds	\$ 1,110,000
Subbase	15,900	cu yds	\$ 10 /cu yds	\$ 159,000
Open Graded Drainage Course, 4"	41,000	sq yds	\$ 6 /sq yds	\$ 246,000
Geotextile Separator	41,000	sq yds	\$ 3 /sq yds	\$ 123,000
Concrete Pavement, Reinforced, 11	26,400	sq yds	\$ 50 /sq yds	\$ 1,320,000
Shoulder, Nonreinforced Concrete	14,600	sq yds	\$ 25 /sq yds	\$ 365,000
Maintenance of Traffic	1	LS	\$ 350,000 /LS	\$ 350,000
Signals	1	LS	\$ 30,000 /LS	\$ 30,000
Miscellaneous	15%		\$ 580,000	\$ 580,000
Estimated Inflation (3.0%/year)	16%		\$ 610,000	\$ 610,000
Total Road Construction Estimate				\$ 5,411,000

Bridge Work

<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Cost per Unit</u>	<u>Item Cost</u>
Bridge Removal	6,700	Sft	\$ 30 /Sft	\$ 201,000
Bridge Construction	15,340	Sft	\$ 145 /Sft	\$ 2,225,000
Miscellaneous	15%		\$ 360,000	\$ 360,000
Estimated Inflation (3.0%/year)	16%		\$ 390,000	\$ 390,000
Total Bridge Construction Estimate				\$ 3,176,000

TOTAL CONSTRUCTION ESTIMATE =

Estimate is in 2011 dollars

Provided by URS Corporation

**I-96/M-100 Interchange Study
Roundabout Interchange Alternative**

<u>Item</u>	<u>Quantity Units</u>	<u>Cost</u>	<u>per Unit</u>	<u>Item Cost</u>
Mobilization	1 LS	\$ 270,000	/LS	\$ 270,000
Pavement Removal	26,100 sq yds	\$ 6	/sq yds	\$ 157,000
Earthwork	81,600 cu yds	\$ 9	/cu yds	\$ 735,000
Subbase	11,800 cu yds	\$ 10	/cu yds	\$ 118,000
Open Graded Drainage Course, 4"	30,400 sq yds	\$ 6	/sq yds	\$ 183,000
Geotextile Separator	30,400 sq yds	\$ 3	/sq yds	\$ 92,000
Concrete Pavement, Reinforced, 11	20,300 sq yds	\$ 50	/sq yds	\$ 1,015,000
Shoulder, Nonreinforced Concrete	10,100 sq yds	\$ 25	/sq yds	\$ 253,000
Maintenance of Traffic	1 LS	\$ 260,000	/LS	\$ 260,000
Miscellaneous	15%	\$ 420,000		\$ 420,000
Estimated Inflation (3.0%/year)	16%	\$ 450,000		\$ 450,000
Right Of Way Costs	1 LS	\$ 230,000	/LS	\$ 230,000
Total Road Construction Estimate				\$ 4,183,000
 Bridge Work				
<u>Item</u>	<u>Quantity Units</u>	<u>Cost</u>	<u>per Unit</u>	<u>Item Cost</u>
Bridge Removal	6,700 Sft	\$ 30	/Sft	\$ 201,000
Bridge Construction	11,780 Sft	\$ 145	/Sft	\$ 1,709,000
Miscellaneous	15%	\$ 290,000		\$ 290,000
Estimated Inflation (3.0%/year)	16%	\$ 300,000		\$ 300,000
Total Bridge Construction Estimate				\$ 2,500,000
TOTAL CONSTRUCTION ESTIMATE =				\$ 6,683,000

Estimate is in 2011 dollars
Provided by URS Corporation

**I-96/M-100 Interchange Study
Relocated EB Ramps Interchange Alternative**

<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Cost per Unit</u>	<u>Item Cost</u>
Mobilization	1	LS	\$ 400,000 /LS	\$ 400,000
Pavement Removal	36,200	sq yds	\$ 6 /sq yds	\$ 218,000
Earthwork	147,200	cu yds	\$ 9 /cu yds	\$ 1,325,000
Subbase	18,500	cu yds	\$ 10 /cu yds	\$ 185,000
Open Graded Drainage Course, 4"	47,500	sq yds	\$ 6 /sq yds	\$ 285,000
Geotextile Separator	47,500	sq yds	\$ 3 /sq yds	\$ 143,000
Concrete Pavement, Reinforced, 11'	33,500	sq yds	\$ 50 /sq yds	\$ 1,675,000
Shoulder, Nonreinforced Concrete	14,000	sq yds	\$ 25 /sq yds	\$ 350,000
Maintenance of Traffic	1	LS	\$ 420,000 /LS	\$ 420,000
Miscellaneous	15%		\$ 690,000	\$ 690,000
Estimated Inflation (3.0%/year)	16%		\$ 730,000	\$ 730,000
Right Of Way Costs	LS	x	- /LS	-
Total Road Construction Estimate				\$ 6,421,000
 Bridge Work				
<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Cost per Unit</u>	<u>Item Cost</u>
Bridge Removal	6,700	Sft	\$ 30 /Sft	\$ 201,000
Bridge Construction	15,340	Sft	\$ 145 /Sft	\$ 2,225,000
Miscellaneous	15%		\$ 360,000	\$ 360,000
Estimated Inflation (3.0%/year)	16%		\$ 390,000	\$ 390,000
Total Bridge Construction Estimate				\$ 3,176,000
 TOTAL CONSTRUCTION ESTIMATE =				\$ 9,597,000

Estimate is in 2011 dollars
Provided by URS Corporation